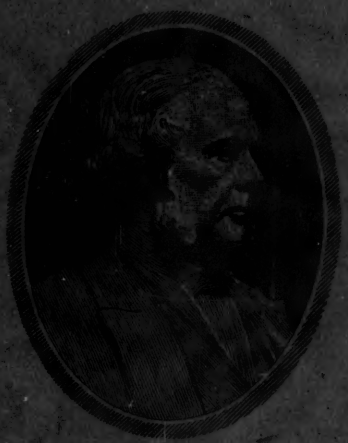
XXXI QUARTERLY No. 122

The British Journal of Surgery

Medical Library



LISTER

OCTOBER, 1943

BRISTOL: JOHN WRIGHT & SONS LTD.

LONDON: SIMPKIN MARSHALL (1941) LTD., 12, OLD BAILEY, E.C. 4

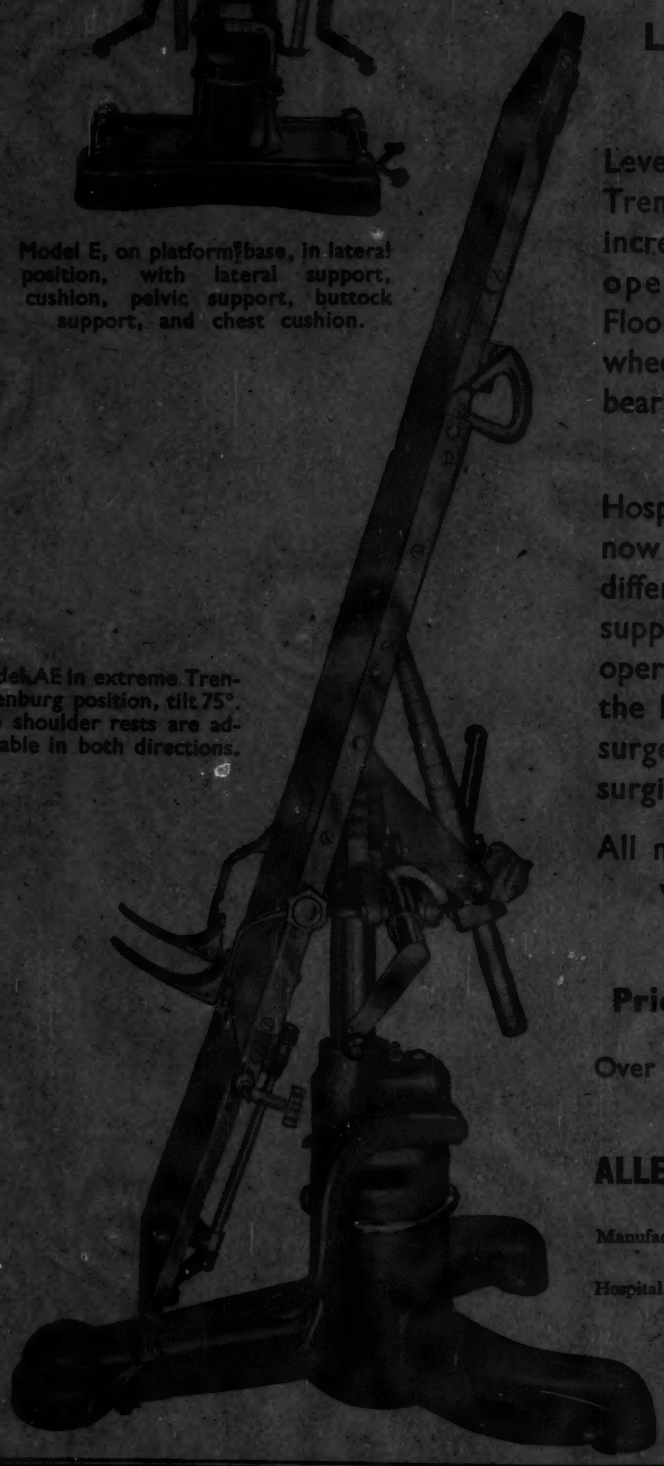
WHOLESALE DISTRIBUTORS: WM. DAWSON & SONS LTD.
43 WEYMOUTH STREET, LONDON, W.1.

UNITED STATES OF AMERICA: THE WILLIAMS & WILKINS COMPANY, BALTIMORE, *Sole Agents*

Entered as second class matter at the Post Office at BALTIMORE under the Act of March 3, 1879. (Sec. 225 P. L. & R.)

St. Bartholomew's Hospital Operation Table

Model E, on platform base, in lateral position, with lateral support, cushion, pelvic support, buttock support, and chest cushion.



Model AE in extreme Trendelenburg position, tilt 75°. The shoulder rests are adjustable in both directions.

Latest Improvements
include
Easy-to-operate Release Lever for lowering the table; Trendelenburg position increased to 75° tilt; Foot-operated rubber-covered Floor Brake, and rubber-tyred wheels fitted with self-oiling bearings.

The St. Bartholomew's Hospital Operation Table is now manufactured in five different models and thus supplies a range of modern operation tables embodying the latest ideas of well-known surgeons for carrying out surgical operations.

All models can be supplied with either tripod or platform base.

Prices from £89 10s. 0d.

Over 1200 of these tables are in use at home and abroad.

ALLEN & HANBURYS LTD.
LONDON, E.2
Manufacturers of Surgical Instruments and Appliances
Sterilized Surgical Sutures,
Hospital Furniture, and Electro-Medical Apparatus

Showrooms:
48, Wigmore Street, W.1

THE
BRITISH JOURNAL OF SURGERY

VOL. XXXI OCTOBER, 1943 No. 122

ANATOMY AT THE BARBER SURGEONS' HALL*

BY SIR HUGH LETT, BT., C.B.E.

THE Thomas Vicary Lecture was founded by the Barbers' Company to commemorate the close association that existed for over 200 years between the Barbers and the Surgeons in the days of the United Company, and it is named after one who was Serjeant Surgeon to Henry VIII and three of his successors, five times in all Master of the old and new Companies, and among other great services did much to promote the study of anatomy in this country.

We know little of the early life of Thomas Vicary, but it seems that he was engaged in a moderate practice at Maidstone until one day by a happy chance he was summoned to attend King Henry VIII for his "sore legge". He made the most of his opportunity and by his skill and personality, aided, perhaps, by a little good fortune, he made such a favourable impression that he was appointed one of the King's Surgeons. It was not long before he received a further mark of the Royal favour, for by a Grant dated April 29, 1530, he was appointed to succeed to the post of Serjeant of the King's Surgeons and Chief Surgeon to the King on the death or resignation of Marcellus de la More, who then held that office. In the same year he was elected Master of the Barbers' Company. Vicary was, therefore, in a position of great authority, for in virtue of his royal appointment he was the principal surgeon in the land, and as Master of the Company he had much to do with the control of those who practised surgery in London and its immediate neighbourhood.

Vicary was doubtless conscious of his responsibilities and anxious to do what he could to improve the general standard of surgery, for at this time it was very low, many surgeons were supremely ignorant, unqualified practitioners abounded, and quackery was rife. Thomas Gale says that at the Battle of Montreuil (1544) there was "a great rablement that tooke upon them to be chirurgions, some were sowe-gelders, and some horse-gelders with Tinkers and Coblers. . . .", and he adds with heavy sarcasm, "in two dressings they did commonlie make their cures whole and sound for ever, so that they neither felt heate nor cold nor yet no maner of paine after".

There were then two groups of surgeons, the minor surgeons or men of the short robe, who were members of the Barbers' Company, and the master surgeons, the men of the long robe, who belonged to the Guild or Fellowship of Surgeons.

FIG. 98.—The Act of Union of the Fellowship of Surgeons and the Barbers' Company, 1540. (*Hans Holbein.*) The original picture is in the possession of the Barbers' Company.

Vicary seems to have realized that if they became one body it would be far easier to make and carry out effective plans for the advancement and regulation of surgery, and for the education of those who intended to practise it, so he set to work to bring them together. The negotiations may have been a little difficult, for the Surgeons' Guild, though small, was very exclusive, its fourteen members were the *élite* of the surgical profession and their social position was considerably higher than that of most of the surgeons in the Barbers' Company. On the other hand, if they joined the Barbers they would enjoy the advantages of a Hall, the privileges of a City Company, and a share in the not inconsiderable property the Barbers then possessed. The Company for its part would gain in prestige, and

*The Thomas Vicary Lecture delivered at the Royal College of Surgeons, April 2, 1943.

its control over surgeons and their practice would be materially strengthened. The Guild seems to have had neither money nor property to bring into the common pool, but this the Company could afford to overlook for it was then flourishing and had a larger membership than any of the other City companies. In due course agreement was reached, the Act of Union of the Barbers and Surgeons was passed and it received the Royal Assent on July 25, 1540.

Vicary's influence with both bodies and at Court must have been an important factor in bringing the union into being, and it is significant that in the great picture which Holbein painted to commemorate the event (*Fig.* 98), Vicary is the one to whom the King is handing the document, although he was not Master of the Barbers' Company when the Act was passed, nor did he, in fact, become Master of the new Company until September in the following year.

The formation of the Barber Surgeons' Company is one of the landmarks in the history of English surgery, but it was of even greater importance in the effect it had on the teaching of anatomy in this country, which, until then, had been almost entirely neglected and was far behind the teaching on the Continent.

The development of anatomy owes much to the great movement of Naturalism in Art which began about the middle of the fifteenth century, and above all to Leonardo da Vinci, who prepared the way for Vesalius. It is interesting that the foundations of modern anatomy were laid not by medical men but by artists, notably Dürer, Michael Angelo, Raphael, and Leonardo da Vinci. Leonardo, that great anatomist who it is believed dissected more bodies than any of his contemporaries or predecessors, did not work in the universities but in the hospitals at Florence, Milan, and Rome, while Michael Angelo took a house where he dissected bodies sent to him by Columbus. Italy was then far ahead of other countries and dissection was permitted in Venice and other large towns and cities which had no universities. It is true that outside Italy it was authorized at Montpellier in 1377, in Vienna in 1404, and Paris in 1478, but it was seldom practised at either Montpellier or in Paris, and Richter says that in Vienna only nine public dissections were performed during the whole of the fifteenth century.

The neglect of practical human anatomy was largely due to the attitude of the religious bodies, for they regarded dissection as sacrilege; illness, they said, was a punishment to be accepted without question and borne with humility, and thus progress was impossible until the Pope, Sixtus IV (1471–84), gave a general sanction for dissection in the early days of the Renaissance.

When the United Company was formed, dissection was already widely recognized and practised in many of the universities on the Continent, and Paris had been one of the most important centres of anatomy for some forty years. Here, as elsewhere, the influence of Galen was supreme, but in 1533 the young Belgian, Andreas Vesalius, came to Paris to study under Sylvius and Guinterius, and then the placid course of its academic anatomy was rudely disturbed. His restless genius was profoundly dissatisfied with what he found, for dissections on the human body were few and perfunctory, and on the rare occasions when they were performed, Sylvius, who lectured from the writings of Galen, followed him blindly and paid little attention to the work of his dissector. If the parts that were displayed did not conform to what Galen had laid down it was perhaps tiresome, and yet it was of little consequence, for the words of Galen were beyond dispute. Vesalius rebelled and quarrelled with Sylvius. Why, he asked, should these writings of 1300 years ago, with their errors and shortcomings, be regarded as sacrosanct? Galen, he maintained, was not always right and his anatomy was incomplete, many bodies must be examined, their dissection made by skilled hands, and the findings carefully observed and recorded before the science of anatomy could be placed on a sure foundation. On leaving Paris he spent a short time at Montpellier, and then, after visiting Venice, he went to Padua, where he was appointed Professor in 1537. Here his genius had full scope, he revolutionized the study of anatomy, he did away with dissectors, demonstrators, and the Lecturer's chair, dissected the body himself, and was his own demonstrator. In 1542, when he was only 28, he completed his magnificent work, *De humani corporis fabrica.*

We see, therefore, that great progress had been made on the Continent, but in England the teaching of anatomy was indeed negligible. Then, in 1540, came the Act of Union of the Barbers and Surgeons, with its vital clause which gave them the right to claim yearly the bodies of four criminals who had been executed, and to dissect them or use them in any other way for the advancement of anatomy and surgery.

This concession was of the greatest importance, for not only did it authorize dissection in England for the first time, but it provided subjects for demonstrations and lectures. The Company promptly took advantage of its new privileges, and before the year was out Master Vicary, accompanied by some other surgeons, interviewed the Sheriffs and asked that the body of one of the next batch of criminals executed at Tyburn might be given to them.

The minutes of the proceedings of the new Company during the first ten years of its existence are, unfortunately, lost, but it is more than likely that Vicary himself was the first Reader in Anatomy in view of his position as Serjeant Surgeon to the King and a past Master of the old Company. This is, perhaps, supported by his work, *A Profitable Treatise of the Anatomie of Man's Body*, which was the first book on anatomy to be printed in English. It was very popular

and it was read for at least 100 years, as the last and ninth edition was published in 1641. In the preface Vicary emphasized that it was intended for young surgeons only, "not for them that be expertly seene in the Anatomie", and the book closes with the words, "this sufficeth for young Practitioners".

Various writers have claimed that John Caius was the first to introduce dissection into England and the first to lecture here in anatomy; it has even been said that he was responsible for the clause in the Act of Union which gave the Barber Surgeons the power to claim the bodies of four criminals and to dissect them in their Hall. But Caius was out of England from 1539 to 1544 or possibly later. He went to Padua in the year before the Company was formed, where, after taking his M.D. in 1541, he held the appointment of Professor of Greek in the University for two years. He then toured the principal cities of Italy, studying the manuscripts of Hippocrates, Celsus, and Galen, and finally travelled back to England after spending some time in Germany. We must also remember that until he left England Caius had devoted himself mainly to theology, and it is more than probable that his interest in anatomy arose during his stay in Padua and was inspired by Vesalius, with whom he lived for eight months. The credit for introducing dissection into this country and instituting regular courses of lectures and demonstrations in anatomy belongs, therefore, to the Barber Surgeons' Company and to Thomas Vicary, who we may assume was the first to give these lectures. For twenty-five years its Hall was the only place in England where dissection could legally be performed, and none but the Barber Surgeons could claim the bodies of criminals for this purpose until Elizabeth gave similar privileges to the College of Physicians in 1565 and to Gonville Hall, Cambridge, in the same year.

THE TEACHING OF ANATOMY

Instruction in surgery had long been given at the Barbers' Hall, and a diploma which was granted to Robert Anson in 1497 and is now in the possession of the Company shows that even then lectures were given to those who hoped to become surgeons. This diploma states that Anson's examination was conducted "in the presence of a great audience of many right expert men in surgery and others" by a Dr. John Smith, who is described as instructor and examiner to the Company. Anatomy, however, is not mentioned, but soon after the United Company came into being it took an important place in the surgical curriculum and was recognized as a separate subject. In 1556 the Court decided that those who intended to take up surgery must first obtain a Preferment of Grace by passing an examination in anatomy as well as in surgery, and when after a period of probation they were given full rights to practise surgery they were promoted to be Masters of Surgery and also of the Anatomye.

The teaching of anatomy was at first limited to lectures and demonstrations on the bodies from Tyburn. These occasions were known as public anatomies, probably because the subjects were allotted to the Company by the State, but partly perhaps because they were open to a limited number of visitors.

The public anatomies were very important functions; they were held four times a year and

FIG. 99.—Dissection in an Italian School. (*From the "Fasciculus Medicinæ" (Johannes de Ketham), Venice, 1493—"Die Medizin in der Klassische Malerei," by Hollander.*)

lasted for three days. A lecture was given in the morning; this was followed by an important dinner to which distinguished guests were invited, and then, after a convenient interval, there was an afternoon lecture. The surgeons of the Company were expected to attend these lectures and if they were absent for more than two of the three days they were fined. Before very long, however, leave of absence was granted on payment of a small sum and the ordinance was gradually allowed to lapse, but the number of surgeons who did attend was appreciable, and as visitors were admitted many of those present could see little or nothing of the parts on which the lecture was being given. Raised seats were therefore erected in the hall (1568), and at the same time, with a fitting sense of decency, curtains were hung round the table and the body remained covered until the Reader had arrived and was ready to begin his lecture.

The arrangements for lectures in an Italian school at the close of the fifteenth century are shown in a wood-cut in the Italian translation of Mondino's *Anathomia* printed in Venice in 1493 (*Fig.* 99). The Professor is seated in a

great chair with a canopy not unlike a pulpit, the subject lies in front of him on a trestle table, and a demonstrator is about to open the abdomen under the direction of an ostensor. At the Barber Surgeons' Hall the ostensors and demonstrators were replaced by two Masters and two Stewards of Anatomy who were appointed to assist the Lecturer or Reader. The Masters performed the dissection under his direction and they were responsible for seeing that the knives, probes, and other instruments were clean and in good order. They wore white aprons

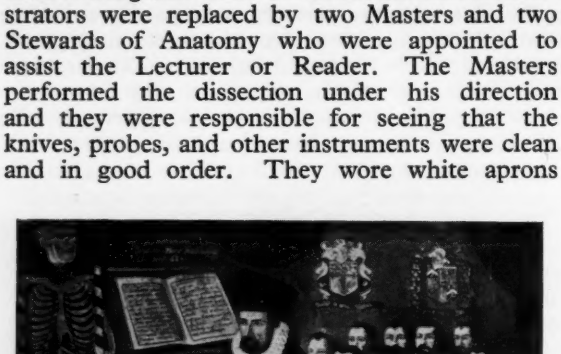


FIG. 100.—John Banester delivering the Visceral Lecture at the Barber Surgeons' Hall, London, in 1581. (*British Journal of Surgery*, 1917, **5**, 8.)

and sleeves, and among other duties they had to supply a wax candle to throw light into the interior of the body, and also two white rods for the use of the Reader during his lectures. Two aprons and two pairs of sleeves with tapes were to be provided for the Reader each day, as it was unseemly that at his afternoon lecture he should wear those he had worn in the morning. An interesting ordinance of 1555 showed some consideration for the comfort of the Reader and others, for the Masters were instructed to see that there was " a matte about the hearth in the Hall ", so that neither the Reader nor those who came to see the anatomy should " take cold upon their feet ". Burton Chance refers to the custom of serving wine and spices at the end of the lecture, and it is suggested that this was because the anatomies were regarded as very exhausting, but it may have been a further kindly provision to protect the Reader and his audience against a chill. In either event a draught of mulled wine must have been very welcome after a long demonstration in chilly surroundings on a winter's day.

The Stewards seem to have been mainly responsible for providing the dinners which were given on the days of the public anatomies, but they also assisted the Masters so that when they were promoted to this office in the following year they might have had some experience in the work.

The well-known picture of John Banester giving the Visceral Lecture to the Barber Surgeons in 1581 (*Fig.* 100) is of great historical interest, and the illustration is taken from an article by D'Arcy Power in the *British Journal of Surgery*. Banester is not seated in the usual high chair, but is standing by the side of the body, one of his hands is resting on the open abdomen, while the other holds a wand with which he points to a skeleton. The two Masters of Anatomy, one holding a probe and the other a knife, stand near him, while the two Stewards are on the opposite side of the table. Banester, the Masters and the Stewards are wearing their white sleeves, but not their aprons, which were probably omitted for artistic reasons and also perhaps in order that the badges of the Reader and the Masters of Anatomy might be seen. The open book has been identified as a copy of the Paris edition (1572) of the Anatomy of Realdo Columbus who assisted and finally succeeded Vesalius at Padua. The skeleton is crowned with the crimson and white colours of the barber's pole, which are also seen on the vertical bars which support the skeleton. Banester's armorial bearings and those of the Company are on the wall, and the scene is evidently laid in the main hall of the building. On the right of the picture we see one of the black curtains which were drawn back at the beginning of the lecture.

In addition to the formal public anatomies which were held four times a year, the surgeons of the Company were allowed to perform private anatomies at the Hall on any subjects they were able to procure, and on these occasions they were entitled to invite their friends and pupils to be present. A copper-plate engraving in an edition of Helkiah Crooke's *Microcosmographia*, dated 1631, shows the author giving a demonstration, but there is nothing to show where it was taking place ; it may have been either at the College of Physicians or the Barber Surgeons' Hall. If at the latter, it was probably a private anatomy, as among other reasons there are no raised seats and the onlookers are standing round a long table.

Helkiah Crooke, who had graduated at Cambridge and was a member of the Company, published the first edition of this work in 1616. A copy of this edition is in the possession of the Royal College of Physicians, but owing to the war it is not at present available. Rather less than forty years previously the Company had passed a wise resolution to the effect that none of its members should publish a book on surgery unless he had presented it beforehand for the approval of the Governors and examiners, under a penalty of £5. Helkiah must have known of it, and in case the Court might consider that his book came within this category he showed great acumen by dedicating it to the Company and presenting it with a copy. This gratified the Court so much that far from fining him £5 they promptly awarded him this sum as a mark of their appreciation.

THE SUBJECTS

The task of selecting subjects and bringing them from Tyburn to the City was originally entrusted to the Masters of Anatomy, but before long it became one of the duties of the beadles. For many years they seem to have travelled to and fro on their lawful occasions without disturbance, but at the beginning of the eighteenth century they began to meet with serious opposition. Surgery and anatomy had made such progress that the Company had increasing difficulty in exercising its authority and its right to insist that no dissection should be performed in London outside its Hall except at the College of Physicians. Surgeons at St. Thomas's and St. Bartholomew's Hospitals began to give instruction to their pupils and the Company was gravely disturbed. Formal complaints were made "against breeding soe many Illiterate and unskillful pretenders to Chirurgery att St. Thomas's Hospital or wherever else ye like ill Practises are used—Where contrary to ye oath of our Company and of ye City of London ye Chirurgeons pretend to qualifie any person how unfitt soever in half a year or a year for the expert practise of our art". William Cheselden was an arch-offender, for he often dissected at his own house and taught pupils there; he was summoned to appear before the Court in 1714, but on his giving an undertaking that he would abandon his "ill practises" his case was dismissed with a caution.

The demand for bodies for dissection rapidly exceeded the supply, with the result that the beadles found their task more and more difficult and the scenes at Tyburn became a scandal. Fights were frequent and sometimes the beadles had to return empty-handed, while on other occasions they were pursued, intercepted, and the body was taken from them, though sometimes with the assistance of constables and others they succeeded in regaining it after an unseemly struggle.

The Court tried to improve matters by drawing on the Company's purse and as a beginning they gave a Christmas box regularly to the hangman; but he was not helpful for he had the prerogative of disposing of the bodies of the dead criminals and probably handed them over to the highest bidder. Presents were also given to the Sheriff's officers, though this was not a success, for at least two of them were dismissed for actively obstructing the beadles. The Court then went a step further and approached and paid fees to the Sheriffs themselves, but even this failed, and in 1729 they were driven to make a petition for a file or two of His Majesty's guards to protect the beadles while they were carrying out their duty. One of the last entries in the minute books on this subject refers to a grant that was made to the High Constable of Holborn for every body brought from Tyburn to the Hall, on the condition that he had actually provided assistance for the Company's officers while they were within his territory, for they were sometimes pursued to the very doors of the Hall itself, and on one occasion the crowd broke its windows.

Stories have been told and books have been written about criminals who came to life again after they had been hanged; they are not very reliable, for as the stories were passed on additions and alterations crept in, though they lost little of their drama in the re-telling. The annals of the Barber Surgeons, however, give trustworthy details of two cases in which the bodies showed signs of life when they reached the Hall, to the great embarrassment of the officials. The first man only lived for three days, and it is remarkable that he should have survived so long, for the weather was extremely cold and before being taken to the Hall he had been "stripped of his apparell", presumably by the hangman who was entitled to claim the clothing of his victims. In the other case the criminal, one William Duell, made a complete recovery although he had been "hung up by the neck" for twenty-two minutes. Hoare, in the Journal of his Shrievalty, quoted by Brayley, says that when he and his brother Sheriff heard that Duell was still alive they determined to seize him and take him back to Tyburn in order to complete his execution, but the news spread so rapidly that by the time they reached the Hall a large crowd had gathered and prevented them from entering it. Their efforts were possibly half-hearted, but they felt bound to take some steps because the hour of the execution was not stated on their warrant and therefore it might be carried out at any time during the day. Duell remained at the Hall until midnight, and when the twenty-four hours had passed the crowd allowed him to be transferred to Newgate, where in due course his sentence was commuted to transportation for life. One version of the story tells how Duell repented of his evil ways, became prosperous, and presented the Company with a handsome screen. It is regrettable that there is no foundation for this moral ending, the screen in question had been at the Hall some thirty years before Duell paid his visit to Tyburn, and, moreover, he was mentally deficient.

THE ANATOMICAL THEATRE

The growing interest in anatomy at the beginning of the sixteenth century is reflected in the number of Continental universities which then began to make provision for dissections and demonstrations. At first, as we have seen, they were generally carried out in a room lent for the occasion, but sometimes in the open air, perhaps in a cemetery; at Tübingen in 1592 a disused chapel was handed over to the anatomists. As dissections were comparatively few and limited to the winter months, the university authorities could not afford to allot any part of their buildings permanently for the purpose, and so we find that for many years rooms were adapted as occasion required, the necessary furniture was brought in

and subsequently removed and stored until it was wanted again. The arrangements, however, were haphazard and some general plan or organization was much needed, until Benedictus of

FIG. 101.—The Theatre of Vesalius. (*From the title page of "De humani corporis fabrica".*)

Padua wrote a treatise in 1500 in which he discussed the use of anatomy, the selection of bodies, and the erection of a temporary theatre. He advised that these temporary theatres and their seating accommodation should be planned on the lines of the amphitheatres at Rome and Verona so that all of those present might have a good view. He stressed the importance of their being well ventilated, with an adequate supply of water, and large enough to allow the dissectors to do their work without being inconvenienced by the spectators.

The principles laid down by Benedictus were generally followed in Italy, and in some of the universities temporary wooden theatres were erected every winter.

The theatre in which Vesalius worked (*Fig.* 101) is shown on the title page of his book, *De humani corporis fabrica*, as a large hall with fluted columns; it was made of wood, and is said to have held 500 people. His fame and teaching attracted large numbers from every rank and station and in the illustration the audience is crowding round him in a way that must have caused him much inconvenience and added greatly to the fatigue of the day's work. On the table are some instruments, with a pen and inkpot, which may refer to his writings and perhaps to his custom of making sketches and drawings for the students; there is also the usual candle for throwing light on the deeper parts of the dissection.

The disadvantages of a temporary theatre became very obvious as the number of lectures and demonstrations increased, and finally, in 1594, the first permanent anatomical theatre was constructed at Padua (*Fig.* 102). It was not built for the purpose, as originally it was a room or rooms in the University buildings, but it was handed over to the anatomists for their use alone, and so they were at liberty to make any permanent arrangements for the furniture and accommodation of the spectators that they might think desirable. This famous theatre was approximately 40 feet high, but it was only 33 feet long by 30 feet wide, and as the staircases to the galleries were inside the theatre the area that was left for the lecturer and the dissecting table was very limited. There were six of these galleries and they rose very steeply at an angle of about sixty degrees round a small elliptical arena; they were so narrow that the spectators were obliged to stand, but they had an excellent view of what was taking place, for, as Franklin says, the head of the most distant spectator was only 25 feet from the object of the demonstration. The arena and dissecting table were several feet below the first gallery and this helped to give the theatre a funnel-shaped appearance which was very characteristic. There was no rostrum, and following the tradition of Vesalius the professor was expected to stand by the side of the body instead of taking up a detached position and reading his lecture from a distance. The theatre was very dark and demonstrations were conducted by the light of fourteen candles; three of them were placed in a candelabra at each end of the table, and the remaining eight were held by students. Dr. Franklin's work on the *De Venarum Ostiolis*, by

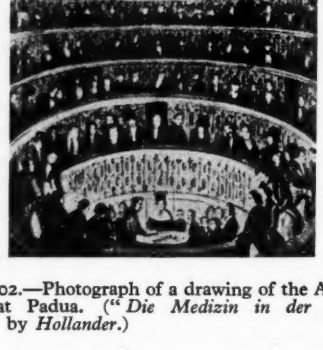


FIG. 102.—Photograph of a drawing of the Anatomical Theatre at Padua. ("*Die Medizin in der Klassische Malerei*", by *Hollander*.)

Fabricius, contains two valuable architect's drawings of this theatre which were made at the suggestion of Professor Singer under the direction of Professor Castiglioni. Reference may also be made to Richter's book for plans made by him.

THE BARBER SURGEONS' THEATRE

Meantime, the influence and importance of the Barber Surgeons' Company as the headquarters of surgery steadily increased; London was growing; the area of the Company's control had been extended to seven miles outside the city, and the number of surgeons grew in proportion. Partly owing to this, but mainly because of the increasing interest in anatomy which no doubt was largely inspired by Harvey's work, there were many requests for permission to conduct private anatomies at the Hall. But there was no special accommodation for them and they became a nuisance in more than one sense. A minute of Oct. 20, 1631, describes them as " a great annoyance to the tables, dresser boards, and utensils in our upper kitchen ", and the Court, who seem to have suddenly awakened to some sense of sanitation and propriety, decided to make a fair convenient room forthwith which should be devoted entirely to private anatomies.

The next ten years are perhaps the most interesting and important in the history of the Company so far as it concerns anatomy, and it is clear that among the members of the Court there were men of vision and action. In 1633 when the Company was entrusted with supervision over all Naval Surgeons and no surgeon was to be impressed for the Navy without the Company's licence, the arrangements for lectures and examinations were modified and improved, but the reforms did not stop there. For some years the surgeons had been very slack in their attendance at the public anatomies, and when they did attend they did not wear their gowns, nor did they take their proper seats but mixed with the crowd —perhaps with the idea that they might come late and go early without attracting attention, a practice that is not entirely unknown at the present day. The Master and the Court were gravely disturbed and a minute records that in consequence of this behaviour the honour and worthiness of the Company had been much eclipsed, " for redresse of w^{ch} enormious exorbitance " it was decreed that every surgeon must attend the morning and afternoon lectures on at least one of the three days of each public anatomy, and further, that he must wear his gown and also take the place allotted to him according to his degree and rank under a penalty of a fine. The Court thus showed that they intended to do all that they could to maintain and improve the standard of surgery, and at the same time they displayed their appreciation of the importance of dignity and circumstance on these public occasions.

Finally, in February, 1636, Michael Andrews, who was then Master and also Surgeon-in Ordinary to the King, proposed that the Company should build an anatomical theatre. Funds were very low, but the Court to their great credit courageously agreed that it should be done. The interest and importance of this decision lie in the fact that when the theatre was completed it was one of the earliest instances of the erection of a building specifically for lectures and demonstrations in anatomy.

The Company was already in possession of a twenty years' lease of some ground and premises adjoining the Hall, so it approached the city authorities and asked for an extension of the lease, explaining that they intended to build an anatomical theatre on the site. The Mayor and Corporation commended the proposal, realizing

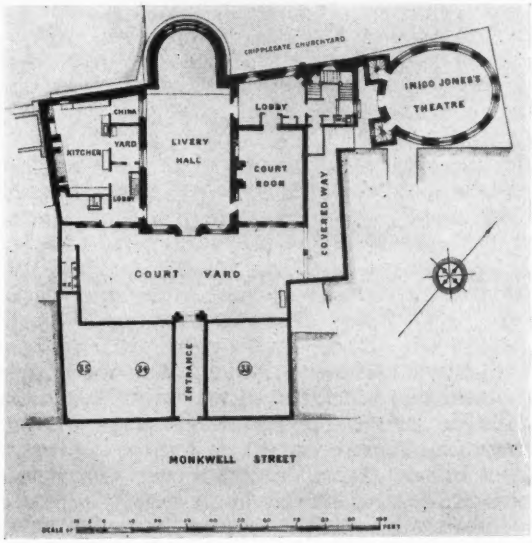


FIG. 103.—Ground plan of the Barber Surgeons' Hall. (*Reproduced from " The Annals of the Barber Surgeons of London ", by permission of Past Master Sidney Michael Young.*)

the advantage it would be to surgery and so to all His Majesty's subjects, and with that public spirit and generosity which have been the pride of the City for so many centuries they granted the Company an additional lease for 200 years at the low rental of £3 a year without any premium.

When this was reported to the Court they agreed immediately and unanimously that the " Theater shall be proceeded in and built according to the plots drawne by His Majesty's Surveigher ". His Majesty's Surveyor was Inigo Jones, and there can be little doubt that he was the architect, although this has been questioned because the drawings seem to have been made by his pupil and assistant, John Webb, and the title is in Webb's handwriting. The above extract from the minutes, however, suggests that Inigo Jones had already been consulted and there is an item in the accounts which refers to certain expenses that were incurred when he came to view the site. He was also visited by members of the Company on a number of occasions, as another entry mentions the cost of these journeys, which were made by water, so that he evidently designed the theatre even if he did not make the

drawings himself. We must remember, too, that Inigo Jones was responsible for the Livery Hall and the beautiful Court Room which were built at the same time, and it is difficult to believe

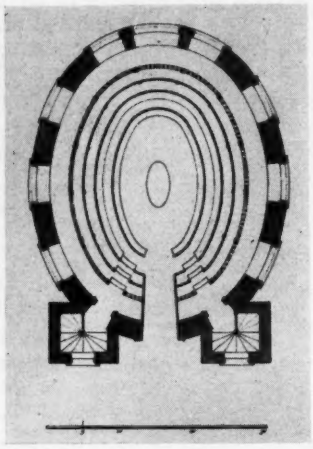


FIG. 104.—Plan of a theatre. (" *Designs of Inigo Jones* " (*J. Ware*), 1756, *Plate* 8—*by courtesy of the Director of the British Museum.*)

that he took no interest in the theatre and omitted it from his general design. Inigo Jones was doubtless aware of the developments of the anatomical theatre on the Continent, and as he knew Italy well it is very probable that he had seen the one at Padua partly because it was so famous and partly because notwithstanding certain disadvantages it had considerable architectural interest; it is therefore instructive to compare it with the one he designed for the Barber Surgeons. The original plans of the latter theatre are in the possession of Worcester College, Oxford, and though they are at present inaccessible, a ground plan published in Sidney Young's book (*Fig.* 103) two illustrations in Ware's *Designs of Inigo Jones* (1756) (*Figs.* 104, 105), and other sources of information give us some idea of the building and the internal decorations and fittings. The two plates in Ware's book are described respectively as " Design for a Theater " and " Its Section ", but a careful examination shows clearly that they refer to the anatomical theatre at the Barber Surgeons' Hall.

The theatre was elliptical in shape and roughly 40 ft. long by 30 ft. wide, so that its area corresponded to some extent with that of the theatre at Padua, which was 33 ft. by 30 ft. At the Barber Surgeons' Hall, however, the staircases which gave access to the seats were placed outside the theatre in two square turrets, one on either side of the entrance façade, and this ingenious arrangement gave much more room for seating accommodation. Both theatres were two stories high, but the London theatre had an oval-hipped roof and a cupola.

The interior conformed to the type of the Roman amphitheatre as exemplified at Padua. There was a small oval arena where the table was placed, and round it were four rows of seats, but there was an open sector opposite the door for the entrance of the Master, Reader, and others on ceremonious occasions. The tables, seats, railings, and doors were all made of cedar wood, the seats were carved and the walls were adorned with the figures of the seven liberal arts, the seven planets, and the twelve signs of the zodiac; there were also niches and brackets for skeletons and other anatomical preparations. The Court gave instructions that the constellations of the heavens should be painted on the ceiling, but this had to be postponed, very probably because of the additional expense, and here it is interesting to recall that some years previously Inigo Jones had been entrusted with the redecoration of the Star Chamber.

The signs of the zodiac refer to the old astrological doctrine which laid down the influence of heavenly bodies on various parts of the human body and indeed on life itself. Its origin is lost in antiquity, but it had been accepted by the Church and medical profession for many hundreds of years. An edition of Mondino's *Anathomia* published at Strasburg in 1513 contains a woodcut which illustrates the supposed relation of the signs of the zodiac to different parts of the body, and we find that in the early days of the Company (1557) those who wished to take up

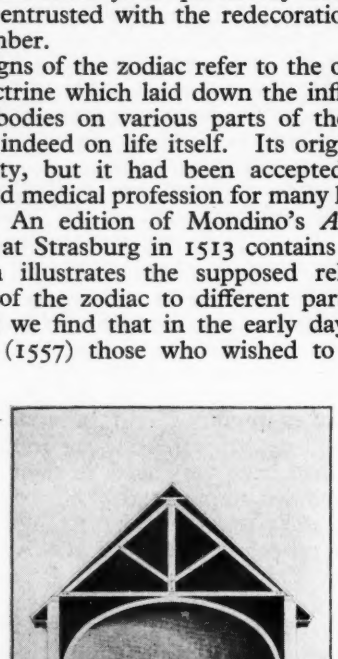


FIG. 105.—Section of the theatre shown in *Fig.* 104 (" *Designs of Inigo Jones* " (*J. Ware*), 1756, *Plate* 9—*by courtesy of the Director of the British Museum.*)

surgery had to pass an examination in the twelve signs as well as in rudimentary anatomy and surgery in order to obtain their Preferment of Grace.

The cost of building the theatre seems to have been nearly £1000 so far as can be gathered from

Sidney Young's work, and the Company employed its own labourers to do the necessary digging for the foundations; they were paid one shilling and fourpence a day with an additional penny for breakfast money.

The opening of the theatre in 1638 was a great occasion, and the Company spared no pains in their efforts to make the ceremony as brilliant as possible. Many distinguished visitors were present, including the Lords of the Privy Council, a public anatomy was performed and Dr. Meverall, "an auncient Phisitian of the Colledge" and one of its most distinguished Fellows, was invited to act as Reader. A dinner, of course, played a very important part in the proceedings, and the Princes' cook, a Mr. Cooper, was consulted. He attended a preliminary dinner at "The Dragon", in Cheape, where the general arrangements were discussed, and for a fee of £5 he agreed to supervise the purchase of provisions and the preparation and serving of the dinner. The Great Parlour was hung with tapestry by John Bludder of the King's Wardrobe, and in order to do special honour to their lordships twelve members of the livery were appointed to attend and wait upon them in their gowns and bring them the various dishes. The total cost of the dinner was £93 5s. 8d., and as nearly two-thirds of this was spent on food one is tempted to wonder what Cooper received in commission. It is a little surprising that the vinctner's charges for wine only amounted to £8 3s., but a good many of those present probably drank either beer or strong beer, for which the bill was £1 15s. 4d.

It all seems to have been a great success, and Dr. Meverall was subsequently presented with a piece of plate engraved with the Company's arms to mark the occasion. It is perhaps an anticlimax to read that after this expensive dinner a silver spoon was missing.

The building of the anatomical theatre and the imposing ceremony with which it was opened, considerably increased the prestige of the Company. The reforms which added so much to the dignity of the public anatomies were not allowed to lapse, and, indeed, not long afterwards it was decreed that on these occasions all approved surgeons must wear their caps and other members of the livery their hats. Samuel Pepys attended a public anatomy twenty-five years later (1663), possibly on the invitation of his friend, John Knight, Surgeon-General to the Forces in the Dutch Wars, who was then Master. Pepys was impressed by the dignified entry of the Master, the Court, and the Reader, and although he does not discuss the lectures, he records his enjoyment of the fine dinner and the conversation of the learned company. He also tells us that between the dinner and the afternoon lecture Dr. Scarborough took him with a small party to see the body of a seaman who had been hanged for robbery. This he found very unpleasant, and when they returned to the hall for further talk before attending the afternoon lecture it was, as he fervently says, with great satisfaction to him.

The theatre, which was built by the greatest English architect of the day, was evidently regarded as one of the most attractive buildings in London. Horace Walpole considered that it was one of the best works of Inigo Jones, and Pepys paid it a second visit in 1668 when, as he says, he and a Mr. Harris "repaired after dinner to the Surgeons' Hall there to see their theatre which stood all the fire". Even in 1783, after forty years' disuse, and when its glories were departed, the *Gentlemen's Magazine* described it as a masterpiece of its kind.

The future seemed to be very bright, but there were difficult years ahead. The financial resources of the Company were already dangerously low, and repeated levies by the King and Parliament for the maintenance of the army, together with heavy demands for the relief of distress in Northern Ireland, placed such a severe strain upon them that when by a cruel turn of fortune's wheel the Civil War broke out the Company reached the verge of bankruptcy. In 1645 it was £3000 in debt, some of its plate had been sold and the rest was in pawn. The public anatomies had been abandoned in the previous year "because of the distraction of these times", and it is not improbable that in the circumstances some of the Court were glad to be relieved of the expense associated with them, for they cost the Company about £22 on each occasion. But Edward Arris, who had been a Master of the Anatomy, was deeply concerned that the teaching of this subject should be given up and he offered the Company £250 to provide for a Public Anatomy with six lectures every year. His offer was gratefully accepted and he ultimately increased the amount to £510, free from any trust, but on the understanding that the lectures would be continued, a gentleman's agreement which has been honourably observed.

John Gale followed this excellent example, and ten years later, by his will, dated August 13, 1655, he left an annuity of £16 for a lecture to be called Gale's Anatomy. The Court decreed that these lectures should be on osteology, and as the public anatomies were held during the cold months of the year it was decided that Gale's Lectures should be given on three consecutive days in July. These two bequests were entrusted to the Surgeons when they separated from the Barbers, and the lectures have been combined under the title of the Arris and Gale Lectures; three of them are now given annually at the Royal College of Surgeons on subjects relating to human anatomy and physiology.

Arris was a generous benefactor; in addition to the above gift he lent the Company £214, he presented it with four silver flagons, and, when it was finally obliged to sell all the plate, he bought the cherished Grace Cup of Henry VIII and gave it back to the Company. His portrait is in the possession of the Company and he also

appears in a picture painted in 1651 in which Sir Charles Scarborough, who was then Reader in Anatomy, is conducting a demonstration; Arris, who was Master at the time, is seen holding up a partially dissected arm.

The Company gradually weathered the storm, its importance and the extent of its work increased, and by 1710 it was examining 500 surgeons and surgeons' mates for the Navy every year, apart from its other activities. But as time passed the theatre grew old and became seriously in need of important repairs; this placed the Company in a quandary as these repairs could not be entrusted to an ordinary builder owing to the unusual structure of the theatre. The Master, Ambrose Dickins, who was Serjeant-Surgeon to the King, approached his friend the Earl of Burlington, that distinguished patron of the arts who was himself a skilled architect, and asked for his advice. Lord Burlington gave it readily, and not only superintended what was done, but generously defrayed the cost as a tribute to the memory of Inigo Jones.

Meantime, the domestic relations between the Barbers and the Surgeons became increasingly difficult; they had long been uneasy bedfellows, and at length, after 205 years, the union was dissolved and the Barbers reverted to their single name, the Barbers' Company, while the Surgeons obtained a new title and became the Surgeons' Company. Shortly afterwards the Surgeons offered to rent the theatre, gallery, and dissecting room for one guinea a year until they could build a theatre of their own. The Barbers, however, still smarting from their desertion by the Surgeons, countered this by a demand for £80 a year and £100 towards the cost of the Parliamentary inquiry, but the Surgeons do not seem to have made any advance on the nominal sum they offered and so the negotiations came to an end.

The theatre was no longer of any use to the Barbers, and thus we reach the last and rather sad page in its history. It died from neglect and a rapid decline in 1785, when it was pulled down by a contractor. Its fittings and materials were sold for £20.

When the College of Physicians moved to Warwick Lane, Christopher Wren included a very fine theatre in his designs for their new house. It was placed over the main entrance and was surmounted by a dome with a straight-sided tapering lantern. High above the main building was a gilt ball to show that medicine is universal. It was very conspicuous and we read that it could be seen from miles around, but the irrepressible Samuel Garth deprived it of some of its dignity by irreverently calling it "the gilded pill", a term which made a strong appeal to the popular sense of humour. The unusual design of the dome gave rise to a certain amount of criticism, but, as Stratton points out, Wren was probably influenced by his anxiety to concentrate as much light as possible on the centre of the theatre and so he had to sacrifice some beauty to practical considerations. Internally there were six rows of seats rising round a central arena, where a table and three chairs were placed, one for the president, one for the dissector or demonstrator, and one for the lecturer; the arrangements for seeing and hearing were excellent. The theatre, which was probably completed in 1678, forty years after the one at the Barber Surgeons' Hall, was much admired, and the new College was described as one of the noblest ornaments of the City.

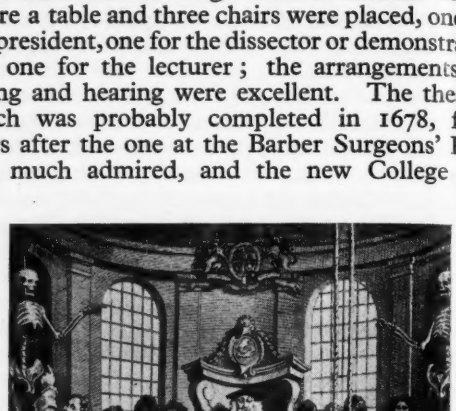


FIG. 106.—"The Reward of Cruelty" (*William Hogarth*).

A brief reference should be made to the theatre shown in Hogarth's "Reward of Cruelty" (*Fig.* 106), for this crude and unlovely setting has been claimed by some as representing the theatre of the Surgeons' Company, by others as the Barber Surgeons' Theatre, and yet again by others as the theatre at the Royal College of Physicians. If, however, we study Hogarth's engraving and compare it with those three theatres, it is quite clear that none of these claims can be admitted. Among many other reasons, his arrangements for the spectators are quite different from those at any of these theatres, as there was a gallery at the Surgeons' Hall, while there were four rows of seats in the Barber Surgeons' Theatre and six at the Royal College of Physicians.

If we take these three theatres separately we can safely exclude that of the Surgeons' Company, for it was octagonal in shape, it was not opened until August, 1751, the year in which the engraving was published, and skeletons were not prepared and placed in the niches in its walls until 1752. Hogarth did, however, borrow certain features from the other two theatres. The physician's hand feeling the pulse, shown on the back of the great chair, is part of the armorial bearings of

the Royal College of Physicians, and this with the Royal Coat of Arms which appears on the wall was, of course, taken from the College, while the figure in the chair is commonly referred to as the President. This figure is supposed to represent John Freke (1688–1756), who was a surgeon at St. Bartholomew's Hospital and Master of the Surgeons' Company in 1747–48. The skeletons of notorious criminals in the walls on either side must have been suggested by those in the Barber Surgeons' Theatre, where, as we know, the skeletons and other anatomical preparations remained undisturbed for many years after it had fallen into disuse.

We must conclude, therefore, that while Hogarth had seen both of these theatres and took something from each, he drew largely on his imagination and did not attempt to make a faithful representation of either of them. His main concern was to point a moral at the end of his pictorial tale, so without regard to accuracy he did all he could to make the details gruesome and terrifying and in this he certainly succeeded.

This is the first occasion on which the Thomas Vicary Lecture has been given within the walls of this College since the destruction of the Barbers' Hall. The loss of the Hall with its beautiful Court Room was a calamity that affected not only the Company but all who cherish the beauty and traditions of our ancient buildings. The Council of this College, mindful of the great benefits their surgical forefathers received from their union with the Barbers and their close association for so many years, felt that they shared in its loss. They hastened to express their profound sympathy and offered such accommodation as they could; it is, perhaps, of some historical interest that the Barbers should have held their next Quarterly Court in the Council Room of the College. But, Master, although your Hall has been destroyed the traditions of your Company can never fade, and they will become more precious with the passing years. We rejoice that your priceless treasures were in a place of safety, and we look forward to the day when a new Hall will rise from the ashes of the old and your treasures will once more be displayed to the honour and pride of your Worshipful Company and of the City of London.

I wish to express my acknowledgements for valuable information and references to Mr. W. R. Le Fanu, Librarian, Royal College of Surgeons; Mr. Samuel Wood, Assistant in the Library; Mr. H. Barlow, Secretary, Royal College of Physicians; and Mr. G. F. Home, Librarian, Royal Society of Medicine.

BIBLIOGRAPHY

BALL, J. MOORES (1928), *The Sack-'em-up Men.* Edinburgh and London: Oliver & Boyd.

BRAYLEY, EDWARD W. (1829), *Londiniana*, **2**, 33.

CHANCE, BURTON (1942), *Bulletin of the History of Medicine*, **12**, 274.

FRANKLIN, D. M. (1933), "The Anatomical Theatre at Padua", *Fabricius, De Venarum Ostiolis*, 25. Springfield and Baltimore: Charles C. Thomas.

GALE, THOMAS (1586), *Galen (Office of a Chirurgion)*, 26b.

The Gentlemen's Magazine (1783), "Barbers' Hall", **53**, Jan., 26.

HOLLANDER, EUGEN (1913), *Die Medizin in der Klassische Malerei.* Stuttgart: Enke.

LANGDON-BROWN, SIR WALTER (1941), "John Caius", *Proc. R. Soc. Med.*, **35**, 61.

RICHTER, GOTTFRIED (1936), *Das Anatomische Theater.* Berlin.

ROLLESTON, SIR HUMPHRY (1939), "The Early History of the Teaching of Anatomy", *Annals of Medical History*, **1**, 203.

SINGER, CHARLES (1925), *The Evolution of Anatomy.* London: Kegan Paul.

SOUTH, J. FLINT (1886), *Memorials of the Craft of Surgery.* London: Cassell.

STRATTON, ARTHUR (1916), *Archit. Rev.*, **39**, No. 233, 69.

VICARY, THOMAS, *Anatomie of the Bodie of Man.* F. T. & P. F. Furnivall, Early English Text Society, 1888.

WALL, CECIL (1937), *The History of the Surgeons' Company.* London: Hutchinson.

YOUNG, SIDNEY (1890), *The Annals of the Barber Surgeons of London.* London: Blades, East & Blades.

SURGICAL EXPERIENCES IN THE MIDDLE EAST
(1941 to July, 1942)

BY ST. J. D. BUXTON

THIS article is intended to present the picture of surgical conditions in the Middle East during parts of 1941 and 1942. Although my work was concerned with injuries and fractures, the prevalent conditions of hospitals and transport personnel and other main features of a medical service in the field were common to all patients passing into the hands of surgeons. Hence description of these will form the first part, and clinical matter the second part of the article.

The Middle East Command varied from time to time, and it is considered that the surgical story of the Western Desert, Egypt, Palestine, and Syria will be easier to follow if other areas

are excluded, although reference will be made to some clinical reports from the Cheren area and the Greek campaign.

PART I

GEOGRAPHY:—
Libya and Egypt.
SURGICAL HISTORY:—
Surgery in the Western Desert:
Field Ambulance.
Casualty Clearing Station.
Fortress Hospital.
Other Medical Units.
The Base Hospitals:
Segregation of Surgical Cases.
The Convalescent Depots.
Liaison with South Africa.

PART II

CLINICAL WORK (principally on bones and joints):—
Early Experiences.
Surgery in Forward Areas.
Surgery at the Base.
Treatment of the Femur Fractured by Gunshot Wound.
Gunshot Wounds of Joints:
The Knee-joint.
The Elbow-joint.
Movement of Joints in Gunshot Wounds of the Limbs.
Amputations.

I. MEDICAL SERVICES IN THE FIELD

GEOGRAPHY

The two topics of interest to the surgeon, which are basically geographical, are 'how long after the wound did the patient reach the forward operating centre', and 'how long did it take him to reach the Base Hospital'.

The military situation changed every few months in the Western Desert during this period, so that many factors were involved in the medical arrangements. To answer the questions adequately and explain the conditions available for primary operation, means of transport, and surgical facilities, the experiences of Libya and Egypt will be separated from the Syrian Campaign—a small one, but one that provided surgical experience.

Libya and Egypt.—The hospitals at the Base are designated General Hospitals and were situated in the area of Alexandria, in the Cairo area, and over a large area designated 'The Canal'. The exact location is purposely not stated, and it would serve no useful purpose to mention their sites. Patients were evacuated from forward areas to these hospitals.

Reference to a map will show that the evacuation from Tobruk to Alexandria meant carrying the patient about 400 miles, the distance from Glasgow to London, whereas from Benghazi to Tobruk was another 300 miles. These distances are considerable by rail alone, but such was never available for the whole journey.

Arrangements existed for operation in Forward Areas and early evacuation to the Base, and detail differed during active fighting and relatively quiet periods.

The forward operating centres were in Field Ambulances, or Casualty Clearing Stations situated in the desert, or in a much larger medical unit in Tobruk. The latter was a fortress hospital when the town was isolated, and later acted as the main operating centre for the Western Desert.

Evacuation was by sea, by air, or by motor ambulance, and by ambulance trains for the distance served by rail. Owing to the distances there were staging units where patients were detained, and at these use was made of the operative facilities available. Air transport was a regular service for patients at certain times and over 800 patients were moved from the 'wire area' to a staging unit or the base in one month. The advantages of this are paramount, when it is considered how quickly a severely wounded man can be moved in relative comfort, so that he reaches the staging unit or Base in a few hours instead of days. Fractures, particularly after operation and splinting, travel well. The disadvantages are the employment of plane and pilot (and so great expense) for transport of a few wounded, and that certain types of cases travel badly (those liable to hæmorrhage and certain head injuries).

Long journeys—200 miles and more—in an ambulance are very tiring even to lightly wounded. A convoy arrived at a staging unit with lightly wounded who had been bumped over tracks and had no opportunity of sleep. This was unavoidable and part of war. I examined a number of the men and could not say any wounds were the worse for the long journey, but reference will be made later to the tiredness of the wounded men.

The ambulance train service carried the wounded in considerable comfort almost to the door of most of the Base Hospitals.

SURGICAL HISTORY

SURGERY IN FORWARD AREAS

Field Ambulances.—The facilities in a Field Ambulance in the desert were novel to every surgeon, however much he had studied the Great War or the Spanish War. A mobile surgical team, detached from a Base Hospital, was sent to this Unit, when considered advisable. This team consisted of a surgeon, anæsthetist, assistant, and two other ranks.

After the Second Libyan battle Major Ian Aird described his experiences at some length. His operating theatre was a 'lean-to' roofed by a 30-ft. black tarpaulin attached to the superstructure of a three-ton lorry. The ward was housed in a similar way. Both were difficult to

heat. Patients were also nursed in tents and in ambulances (*Figs.* 107, 108).

He used surgical instruments and a portable operating table brought with him, travelling by air, rail, and motor transport during different parts of the journey. No essential instrument was wanting. Sterilization was by primus stove. Sterile dressings were brought up, and captured ones, put up in paper containers, were mainly used. Drums could be sterilized by the Casualty Clearing Station. The most satisfactory lighting proved to be a lorry inspection lamp, with petrol-can reflector, run from the tail-lamp of the lorry.

FIG. 107.—Lorry with tarpaulin penthouses in a Field Ambulance, used for operating theatre or ward. Utility van, in which the author travelled.

During a period of 43 days, Aird's team moved on 27 days and the theatre was open on 20 days. Some hundreds of casualties were examined, and cases were selected for retention, such as those which required particular resuscitation, penetrating abdominal wounds, 'sucking' chest wounds, and wounds of the limbs with serious hæmorrhage or threatened gangrene. Although only 31 operations were performed, this was no criterion of the value of the team, and it was thought that troops appreciated the presence of this surgical team so far forward during a time of ebb and flow of the fighting.

Record was made of the time elapsing between hour of wound and hour of admission in 64 cases.

1½ to 6 hours	10	cases
7 to 12 hours	2	,,
13 to 24 hours	26	,,
25 to 36 hours	12	,,
37 to 72 hours	9	,,

and 5 men who were recaptured from enemy hospitals in occupied territory reached the team in more than 72 hours. Conditions did not permit of retention of patients for more than the briefest time; hence, only 5 stayed as long as three nights, and 4 for four to seven nights. Aird considers that the outlook for a patient evacuated 48 hours after an *early* operation is better than that of one who is evacuated over a long distance before operation is done.

Resuscitation was employed in 26 per cent of cases submitted to operation during the work of this team with the Field Ambulance and Casualty Clearing Station. Dried plasma was used as a routine, and 2 to 4 pints of blood by drip only when massive hæmorrhage had caused circulatory insufficiency.

Immediate operation with concurrent intravenous drip is indicated under the condition in which this team was working, in cases of (*a*) serious external hæmorrhage and internal hæmorrhage not compensated by earlier transfusion, (*b*) 'sucking' chest wounds, and (*c*) penetrating wounds of the abdomen.

Of the 18 abdominal wounds seen, only 1 was admitted within twelve hours, and 7 within twenty-four hours of being wounded, although they rarely had to travel more than fifteen miles. All the severe cases of burns had received their injury twenty-four hours previous to admission. These times are of interest in comparison with what occurs in more static warfare and when an army is advancing.

During the Second Libyan battle M & B 693 was given by the mouth in all cases of open wounds and sulphonamide powder was dusted on all wounds operated upon or dressed for the first time.

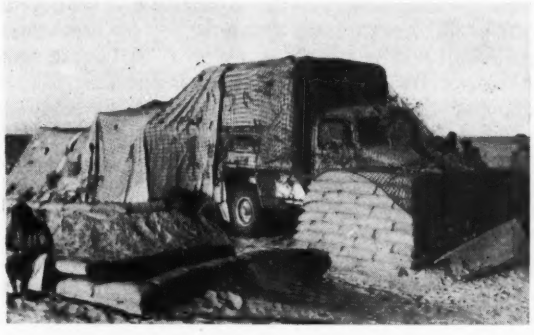


FIG. 108.—Camouflaged lorry and tarpaulins, such as were used by Field Ambulance for a ward in the Western Desert.

It is noteworthy that endotracheal nitrous-oxide, oxygen, and ether was employed as an anæsthetic in as many cases as was pentothal used alone.

The conditions for surgery experienced by this mobile team in the vast desert under circumstances that can only be truly appreciated by those who have fought there, were made even

more difficult in that they were in enemy hands for a time and even dive-bombed.

In another Field Ambulance during the Second Libyan battle, 33 operations were carried out on 136 battle casualties. Of these 80 per cent were wounds of the limbs.

Casualty Clearing Stations.—At this time the Casualty Clearing Stations working behind

FIG. 109.—Protected operating theatre block at Tobruk, June, 1942.

the Field Ambulances were not altogether suitable units for the Western Desert. The surgical equipment and tentage made surgical work less difficult than in the more forward area. In addition to the surgeon on the establishment, a mobile surgical team was added where necessary. The unit was organized for retaining wounded after operation for a longer period than in a Field Ambulance. Under the conditions the surgeon is faced with difficulties of policy. The units were in the desert with a limited quantity of water, accommodation for holding serious cases, and could not be called ' mobile '. All agree than an important function of all field units is to evacuate the wounded to the Base as early as possible, yet the results of surgery are best when early operation is carried out. But the greater the number of operations, the larger the number of patients retained in the Casualty Clearing Stations, as the severely wounded man after operation must be held until fit to travel. Undoubtedly early operation is the ideal, but at this time the surgeons operating in forward areas were definite in their opinion that operations should be limited to those who are *severely* wounded. The practise of operating on all wounded in field hospitals in the desert during an ' ebb-and-flow ' battle, without discrimination, is bad policy. The development of an Air Ambulance service may enable a writer at a later stage of the war to contradict this statement.

Fortress Hospital.—During the time when Tobruk was a fortress, excellent surgical work was carried out there by a large Australian medical unit. The wounded from the perimeter reached the hospital within six hours of injury, and in a month 600 operations were carried out, the maximum for one day being 73. During this month 180 open fractures and 32 wounds of joints were treated by operation.

The buildings were later taken over by a British Unit which further improved the organization of resuscitation and operating rooms. The buildings were bungalow type of barracks for wards and a useful ' block ' for admission, resuscitation, X-ray and operating theatre, and a recovery room (*Fig.* 109). The value of the latter cannot be underestimated, for it makes for great economy in nursing and, being placed near the resuscitation room, facilities for post-operative treatment are already at hand.

It was apparent that the organization in this ' block ' was well arranged. The minor casualty passed through the ' inner circle ' and to the wards, whereas the more severe case had resuscitation if necessary and passed to a waiting room for X-ray or on to the theatre. There was a large room with eight improvised tables for routine wound surgery (*Fig.* 110) and two small theatres for the more difficult work. In the latter, surgeons employed the technique of a major operation with a limited supply of sterile linen, whereas in the large room excision or enlargement of a wound and splinting, when required, were carried out under more difficult conditions, as great economy in the use of towels, gowns, and gloves necessitated the substitution of washed and carbolized mackintoshes for towels and the washing of the gloved hands. There was good lighting by 60-candle-power electric lamps over each table. Facilities for plaster splinting were excellent. Discretion was used as to which cases required an X-ray photograph and the work in that department was of a high standard.

FIG. 110.—The large operating theatre in Tobruk in which eight surgical teams could work. Photograph taken at 10 p.m., and shows the 60-c.p. lamps over tables.

The wards were clean and light, and the flies kept from patients by mosquito nets (*Fig.* 111).

Nursing Sisters worked there at certain times, and their work was appreciated by the patients and took a heavy load from the surgeon's shoulders.

This Hospital did work which is comparable to that of the Casualty Clearing Stations on the Western front during the Great War, but often retained cases longer and evacuation to the Base was not so regular.

Although a busy surgical divisional officer, Lt.-Col. R. Marnham made an instructive report after the Second Libyan battle, covering a period from Oct. 20, 1941, to the end of that year.

During the first month, when the unit was a fortress hospital, over a hundred battle casualties were operated on. The average interval between wounding and reception in hospital was four hours.

During the battle period nearly 700 operations were carried out on battle casualties. Nearly one-half were operated on by two surgical teams nearer the perimeter. The casualties arrived at this section of the hospital six hours after being wounded, and selected cases, such as 'sucking'

FIG. 111.—Ward at the Tobruk Hospital, June, 1942.

chest wounds, were held for three to four days before being transported to the main hospital.

During the first ten days of December over 400 battle casualties passed through the operating theatre. Some had been dealt with in Casualty Clearing Stations. The average time between wound and arrival in hospital was twenty-four hours, and those that arrived later had been held by design at forward medical units.

During the last three weeks of the year, the unit was largely a staging unit for evacuation, but over 400 casualties were operated on. A number of these patients had been wounded three weeks or so, and had been in German medical units.

OPERATIONS

PERIOD 1941	BATTLE CASUALTIES	NON-BATTLE CASUALTIES	TIME OF ARRIVAL AFTER WOUNDING
Oct. 20–Nov. 20	106	160	4 hours
Nov. 21–30	688	18	6 hours (to forward section)
Dec. 1–10	438	23	24 hours
Dec. 11–31	425	66	Up to three weeks

Marnham reported that there were 54 operations for abdominal wounds, with 28 deaths, but it is not stated if any cases survived, nor what number died without operation.

Of the chest cases, 18 died of the 48 which had operations.

There were 547 wounds complicated by fracture, which were treated by operation, and 58 amputations, excluding those of fingers and toes; 15 amputation cases died.

These extracts from the operation register show the great amount of work done under difficult conditions, but in comparative comfort to that of a tented theatre in the desert.

During the early part of 1942 the surgical staff of the hospital changed, and during the Third Libyan battle Lt.-Col. A. Simpson Smith was in charge of the surgical division. Owing to the military events, no surgical report has been available, but it was my fortune to spend a short time at the hospital ten days before the fall of Tobruk. It was clear that the surgical teams had been working expeditiously and with skill and discrimination, and that the organization was good. The surgeons at the Base reported that cases arrived in a better surgical condition than previously. This can be accounted for by experience and by a greater standardization of treatment and splinting, and was due also to the excellent arrangements of evacuation which were made from the hospital to the Bases. The results of this Forward Area surgery were particularly good, as twenty-four hours had usually elapsed before the wounded reached the hospital. It is noteworthy that in a period of eleven days, 1300 patients out of 1658 wounded passed through the operating theatre. In one twenty-four-hour period 271 patients were admitted.

Other Types of Medical Units in the Desert.—There were a variety of these, all of interest and serving particular purposes.

A Casualty Clearing Station was housed underground with excellent accommodation. This had been a forward operating centre, and for some months later was principally a staging unit, but even as such was the unit in which many primary operations were carried out.

Rock was blasted out so as to build good wards, operating theatre, and X-ray room, etc. There were some bedsteads, but most of the patients slept on stretchers resting on racks fixed to the walls. There were some small rooms for severe cases and for officers.

The operating theatre was amply large, and there were rooms for preparation and storage of dressings. Water was laid on and there was an efficient electric lighting system. The South African unit introduced 'neon' lighting over the operating table, which was excellent.

Major Wooldridge and his team dealt with many battle casualties and made fair criticism of the condition of the patients reaching the unit, which was very valuable when one was endeavouring to decide which was the most successful type of wound treatment and splintage for use in the more forward areas. He brought to notice the fallacy of applying skin-tight plaster to wounded limbs which had come late to the surgeon.

At one period wounded were brought to this unit by air from very forward positions, and it was interesting to see the arrival direct from the plane. There was no doubt that fractures of long bones travelled well by this method, but one post-operative cranial injury was moribund,

FIG. 112.—Theatre unit of Mobile Military Hospital (British). This photo was taken before the unit was made desert worthy, with the American markings on the trailer and lorry. The tent is the theatre, to which were attached trailers, fitted as X-ray department, sterilizing plant, and surgical stores.

although when loaded on the plane his condition had appeared satisfactory.

An elaborate Field Hospital functioned largely as a staging unit in the desert. This was a complete hospital on wheels, but on its arrival in the Middle East it was not desert worthy, i.e., had not the wheels, etc., to enable it to travel off a main road. It was interesting in that each mechanical vehicle and trailer was built for a specific purpose with interior fittings. The operating theatre was a spacious tent with floor boards. Trailers were 'backed' against the sides of the tent and openings made. When all was set up, the sterilizing plant in one trailer, the X-ray unit in another, and the dressings, surgical instruments, and equipment in a third, all were in direct communication with the operating theatre. The disadvantage of a unit built in this way is that the destruction of one vehicle by bomb or accident may put the greater part of the hospital out of action (*Fig.* 112).

Similarly some large trucks, built either as a lorry or of the same type as an ambulance, had internal fittings for operating theatre and sterilizing plant.

The principle was made use of by more than one surgical team in converting a vehicle, which was part of the standard transport of the unit, when a theatre was required. Such an improvization was possible and had not the disadvantage of the more elaborate and expensive pattern.

Mobile X-ray units on wheels were in the desert and at the Base, and were of valuable assistance in particular cases. Provision had to be made for cooling of water for developing and washing films (*Fig.* 113).

The account of the Forward Area surgical conditions, work, and operating units extends to the end of the Third Libyan battle. Changes, particularly in the mobile surgical team, were developing, and doubtless will be recorded at a later date. The surgical conditons during the advance to Tripolitania and Tunis have differed owing to these changes and because the immediate evacuation of the surgical case is not so essential when an army is advancing. Further, the use of air transport for the wounded was becoming a much appreciated development of the Medical Services, so that many operation cases do not need to be 'held', but are evacuated early and comfortably the whole, or part, of the journey to the Base.

THE BASE HOSPITALS

These were either large buildings with or without the addition of huts, or constructed units.

When buildings, such were constructed as hospitals, or were hotels or schools.

One modern hospital had every convenience of the best teaching hospital in the United Kingdom. The wards were of 'pay bed' or nursing-home type. The operating theatres were cool, light, and all arrangements first class. There was a developing room for X rays in the 'wash-up' space of the orthopædic theatre. Another hospital had excellent large wards and a suite of operating and plaster rooms which were air conditioned, so that operating was carried out during the afternoon of the hottest weather (*Fig.* 114). Portable X-ray machines were in

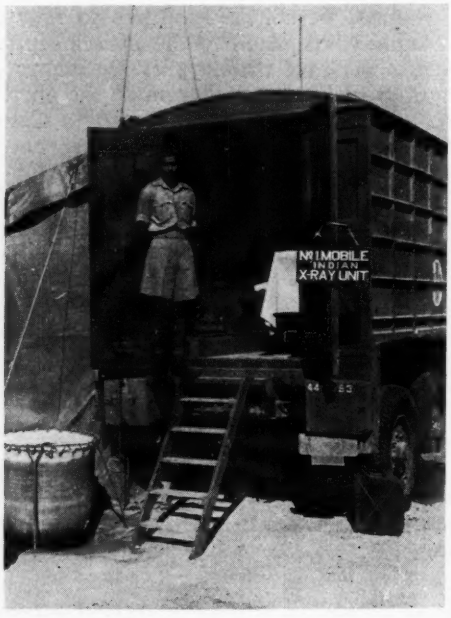


FIG. 113.—Indian mobile X-ray unit, with canvas water cooler in foreground on the left.

use in all theatres of these hospitals. The surgeon had all the equipment he wanted, and in some of the hospitals to which special units were attached (ophthalmic, maxillo-facial, etc.), there was an operating theatre for the special work.

Such luxury was not available in the base hospitals outside the cities. Some of these were entirely hutted and others were largely tented units, but there were huts for specific purposes. Hence there was a block of huts for the more serious cases and officers' wards (*Fig.* 115).

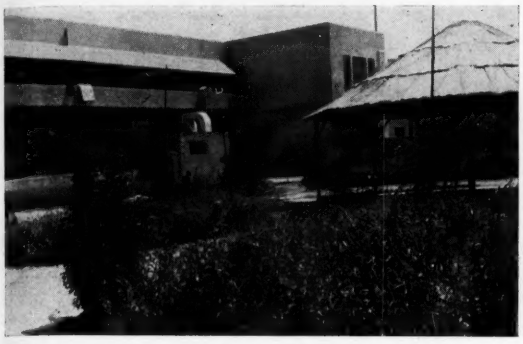


FIG. 114.—Theatre block, with air conditioning. Anti-blast wall is shown. Wards surrounded the garden.

The huts for the operating theatre block were usually built of stone, whereas the wards were often Nissen huts with side windows. The latter were light and easily kept clean, and were excellent for the nursing of fracture cases (*Fig.* 116).

FIG. 115.—Part of a hutted hospital in Egypt.

The usual operating theatre hut consisted of two theatres (or a third for ear, nose, and throat work), anæsthetic rooms, and a plaster room. Lighting was by electricity. At first the theatre lighting was by improvised lamps, and later one type of scialytic lamp was supplied. High-pressure sterilizers were available, but the earlier construction did not make suitable accommodation for housing them. There was ample space for preparing and storing dressings. Covered passage ways extended to the X-ray department. It was seen that each unit made some alteration from the standard plan, and the latest plan was made as the result of experience gained in many hospitals.

Few fittings are required in huts used as wards. In hospitals to which fractures were particularly sent, it was considered that a universal piping system could be used with advantage in place of the Balkan beam. The latter is never easy to arrange and was not a suitable piece of apparatus for use with the standard hospital beds. Some wards had the piping system built in, so that there was a bar running the length of the ward, with uprights

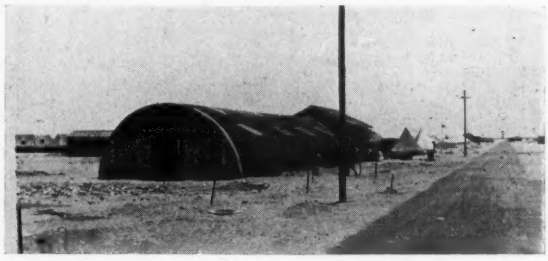


FIG. 116.—Type of Nissen hut in certain hospitals, which make excellent wards.

fixed to the floor and a pipe bar over each bed. This made it possible to arrange weights and pulleys quickly and provided a strong bar to which could be slung a good handle, to enable the patient to lift himself. This construction for a ward is less expensive than Pearson fracture beds for an equal number of patients. It is more suitable for huts than in most buildings. The nursing staff learn the management of the apparatus more easily than they do the correct use of the Pearson bed, whether used with or without a mattress. It was given the name of the Universal Balkan beam (*Fig.* 117).

At busy times wounded could not all be housed in huts in a desert hospital with the 'minimum hut scale'. They would then be in large marquees, several of which would be put together. The site for each tent was dug out, so that when it was 'pitched' the greater part of

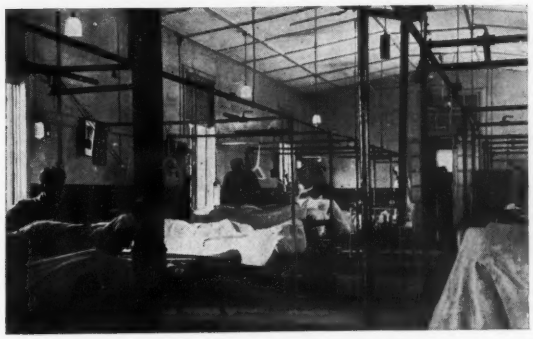


FIG. 117.—Universal Balkan beams in a hospital in Palestine. (*Photo by Major Brewer.*)

the tent was below the ground level. These wards cannot be kept free from sand during part of the year, and so dressings are not carried out under ideal conditions. This was overcome in many hospitals by arranging for all ambulatory patients to go to a 'dressing room' in a hut for change of dressings.

Segregation of Surgical Cases.—There were special teams for maxillo-facial work, for neurosurgery, two thoracic units, and five orthopædic centres. These were attached to hospitals in areas to which there was a reasonable chance of

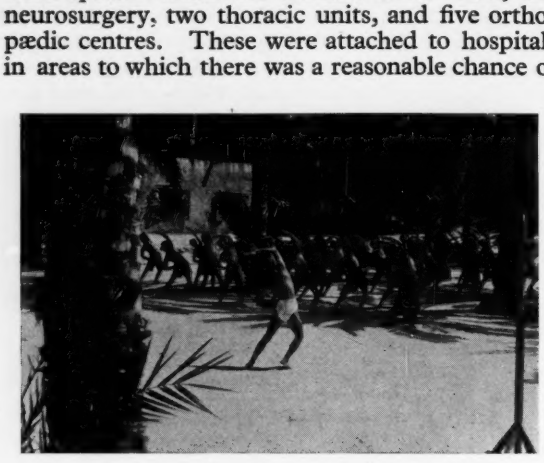


FIG. 118.—Physical training at a Convalescent Depot. (*Photo by P. R.*)

sending the patients requiring special treatment. These units had out-patient departments in the area and had under their care a considerable proportion of the in-patients suffering from the lesion suitable for the particular speciality. Special facilities were available for such patients and a 'follow up' was possible. Fracture cases might be transferred to a Convalescent depot and return to the same surgeon for further treatment.

The Special Surgical Centre arrangement in so large an area adds to the mileage of transport, and at times increased the difficulty of off-loading from trains at particular halts. In Palestine and Syria the delivery of the patient to a special centre was easier than in Egypt owing to the airport and railroad facilities of the hospitals concerned.

THE CONVALESCENT DEPOTS

These were constructed to take 2000 patients. The average stay was eighteen days and rarely did a soldier remain over five weeks in a depot.

The situations were chosen to make transfer of patients easy and to provide suitable facilities for convalescence, in the form of games and swimming. Physical training instructors and masseurs were on the establishment. These units were invaluable for fracture cases. The patients were visited by the surgeon who had looked after them and plasters were changed at the depot if a return to the hospital was not necessary. The soldiers were away from hospital life, had physical treatment and occupational therapy, and a good cinema. In one Convalescent Depot the occupational therapy included bookbinding, carpentering, forge work, and sign-writing, and the garden was a credit to all who worked in it (*Figs.* 118, 119).

LIAISON WITH SOUTH AFRICA

At the end of 1941 it became evident that the war hospitals in the Union were filling up with patients from the Middle East. Correspondence indicated that advantage would occur to any subsequent wounded, if the progress of those already in the Union was seen first hand. Hence a visit was made and all the hospitals in which there were British soldiers and sailors were visited. Much was learnt concerning the conditions of the voyage, and of the progress of the wounded, particularly of those with amputations and fractures. The excellent climate, good food, well-planned and well-built hospitals, and first-class facilities for all forms of remedial treatment were great assets for the sick or injured. Temporary artificial limbs were made at the limb fitting centre—a child of Roehampton—or a modified pylon at the hospital workshop for lower limbs.

The S.A. Medical Service was developing special centres for plastic surgery and other work.

Although only a few words are written on this Medical Base, great credit is due to the workers for the British wounded in the Union—not only for the surgical work, but also for the hospitality to wounded and others.

Sir Edward Thornton, D.G., S.A.M.S., and Colonel Herbert Walker, Liaison A.D.M.S., were kind enough to arrange my programme so that all the surgeons treating our wounded were met. The travelling was four days' flying each way and 1500 miles by train and car. This visit was followed by a monthly surgical correspondence, which enabled us in the Middle East to hear quickly of the condition of the wounded on arrival and contained a critical review of groups of cases. Stimulation for liaison was encouraged and consultants in other branches of Medicine have made comparable tours of equal value.

II. CLINICAL WORK, WITH SPECIAL REFERENCE TO GUNSHOT WOUNDS OF BONES AND JOINTS

In the first half of 1941, outstanding interest was taken in the treatment of shock, the value

FIG. 119.—Occupational therapy workshops at a Convalescent Depot.

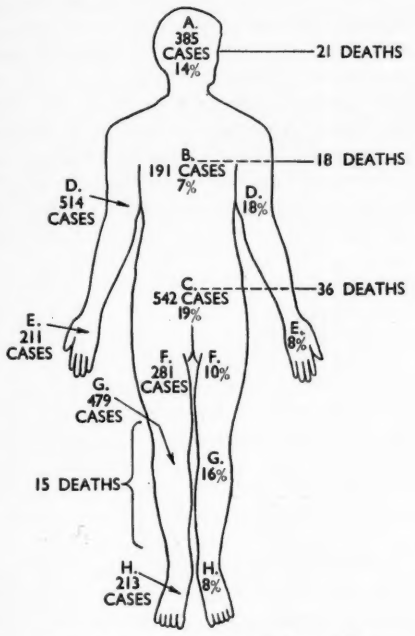
of sulphonamide preparations, and in the method employed in the Spanish War in the treatment of wounds. The treatment of *shock* carried out at this time, and ever since, has been of high

standard. An excellent organization for the supply of blood, plasma, and serum has been of great value, not only in the Western Desert and Syria, but also in the Cheren operations.

Subsequent reference will be made to the use of *sulphanilamide*, for early in 1941 the oral and local administration of this drug was not carried out in any systematic method.

Experience proved that the surgical technique must be different for early cases and those wounded twenty-four hours or more, but that plaster-of-Paris splinting was valuable, both as a treatment of the wound and for travelling purposes. However, certain modifications of plaster-of-Paris technique were made, particularly with regard to the ' splitting of the cast '. Its use was

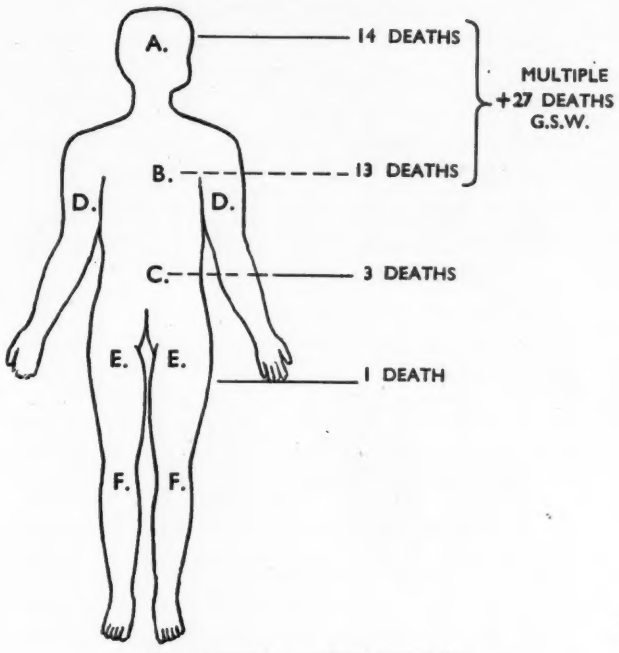
ALL UNITS OF EIGHTH ARMY



Site of Wounds, 2816 Battle Casualties

	No.	*Per cent*	*Deaths*
A, Head, face, neck	385	14	21
B, Chest, upper back	191	7	18
C, Abdomen	542	19	26
D, Shoulder, arm	514	18	—
E, Hand, wrist	211	8	—
F, Thigh	281	10	
G, Leg	479	16	15
H, Ankle, foot	213	8	
Totals	2816		90

AN INFANTRY DIVISION



Site of wounds, 413 battle casualties

	No.	*Per cent*	*Deaths*
A, Head, face, neck	55	13	14
B, Chest, upper back	46	11	Mult. 27 : 13
C, Abdomen, pelvis, buttocks	20	5	3
D. Shoulder, arm, hand	112	28	—
E, Thigh	69	17	1
F, Leg, foot	111	27	—
Totals	413		58

N.B.—Fatal cases are not included in cols. 2, 3.

Fig. 120.—Regional distribution of wounds during part of a battle, compiled in a forward area.

The majority of surgeons working in the Middle East in early 1941 had not had the opportunity of treating gunshot wounds. They were fascinated by the work of Winnett Orr and Trueta. The treatment of wounds in Barcelona by surgery and immobilization of limbs in plaster-of-Paris was known to them. The outstanding difference between those wounded by bomb in that city and those wounded by any missile in the Western Desert, around Kassala or Cheren, and in Greece, was that the former were in the hands of the surgeon in a few hours, whereas in the Middle East it was the exception for wounded to be in the surgeon's hands in six hours and frequently twenty-four had elapsed before the soldier reached a forward operating centre. This was in no way comparable to the conditions of a city hospital. never restricted to wounds complicated by fracture. In the earlier period, plasters were changed soon after arrival at the base and at frequent intervals; dressings of wounds not covered by plaster were carried out daily or every other day, a routine soon discarded when it was realized that infection was less, and healing quicker, with a more limited change of dressing.

Later, it was satisfactory to hear that many wounded reached a forward operating area with the primary dressing unchanged. Surgeons soon appreciated that if there was established sepsis when the patient reached an operating centre, surgical interference, such as an excision or search for a small inert foreign body, was contra-indicated. The few cases of clinical gas gangrene in Greece occurred in limbs when an operation

called débridement had been done too late or insufficiently; some of them had been splinted with plaster-of-Paris. (Lt.-Col. D. C. Donald, November, 1940–April, 1941).

This clinical survey of the earlier period is intended to record briefly the surgical experiences which led up to a great improvement in wound treatment, so that some standardization was possible. It would be out of place for me to include in this article any details of the present knowledge and results of the treatment of wounds of the head, neck, chest, and abdomen. Hence a somewhat detailed account will be given of the treatment of gunshot wounds of bones and joints, as appeared the most satisfactory under the existing conditions in the Western Desert and at the Base during 1942.

THE GENERAL PRINCIPLES OF THE TREATMENT OF GUNSHOT WOUNDS OF BONES AND JOINTS

1. In Forward Areas

Treatment of *shock* is required in a limited number of cases, but every patient with a fracture of the femur, severe wounds of the knee-joint, upper end of leg, and shoulder, and a number of arm wounds should be given anti-shock treatment, even if on admission the condition appears satisfactory. It was never reported that fractures of the femur were dying from shock or after operation in forward areas, as precautions were taken. This was important in the desert, as many wounded were dehydrated owing to a limited ration of fluid intake. The important anti-shock treatment is rest and fluid, and, if the temperature is low, warmth. Morphia is a routine in a severely wounded man, and no harm from its use was recognized. Blood transfusion is required in selected cases. No form of blood is of value in the treatment of fatigue associated with battle, nor with the condition best termed 'travel tiredness'. Rest, sweet tea, and morphia are required for these conditions. Anti-tetanic serum is routine and probably all soldiers have had tetanus toxoid inoculation. Some surgeons employ anti-gas-gangrene serum in selected severe cases, but its value is little without adequate surgical treatment.

The value of *sulphonamide therapy* is not yet established, but sulphanilamide was in use in 1942. It was customary to give a prophylactic course of between 20 g. and 25 g. orally during the first five days. Although a regular dosage system was advised, this could seldom be carried out exactly, owing to evacuation. Local treatment is stated below. Subsequently, oral therapy was employed in varying ways, some surgeons continued small doses, others gave periodic five-day courses, others employed it when there was a rise of temperature, and others for twenty-four hours prior to a change of plaster. It appeared to me that there was no evidence that any oral dose of sulphanilamide, after the prophylactic course, was of value to a single soldier with a wound complicated by a fracture, hence its use was stopped in these cases, and I see no reason to re-employ it, although it usually limits the rise of temperature after the change of a plaster over an infected limb if 5 g. are given over thirty-six hours prior to this operation.

The *operation* in the forward area differs in no way from that employed for a large wound of muscle. The technique of the operation carried out when the patient is on the operating table within a few hours is now recognized as being unsuitable for wounds dirty from clothing and debris being in the tissues, and when a certain time has elapsed since the wound was received. It is probable that to be dogmatic and state a definite number of hours is erroneous, because conditions such as the climate and the soil on which the fighting takes place appear to be factors in delaying or increasing the development of infection.

Suture of Gunshot Wounds.—There is no place for primary excision and suture of wounds complicated by fracture of a long bone in the Middle East. A few cases of gunshot wounds of the knee with fracture of the patella (with intact femur and tibia) have been treated by excision of the patella and wound closure without drainage in forward areas, with success, even with suppuration of a leg wound soiling the dressing over the knee, but this is not advocated as routine treatment.

The '*delayed operation*'—i.e., not carried out early, but before there is visual evidence of infection—consists of a cleansing of the skin, excision of $\frac{1}{8}$ in. to $\frac{1}{4}$ in. of the edges of jagged skin, and the removal of all dead or dying tissue and trimming of muscle. Hæmostasis is desirable. The wound is packed after dusting the surface with sulphanilamide powder. The pack should be of gauze infiltrated with vaseline. Ribbon gauze should not be used. Surgeons at the Base reported at times that wounds had been 'plugged' in forward areas, so that discharge would not flow out around the pack. Care must be taken that the pack is not a plug, as swelling of muscle may tend to close the wound and not necessarily push out the packing during the first few days of treatment.

In the thigh, division of the fascia by extension of the wound up and down, or by transverse incision with or without counter drainage may be advisable.

Rubber drains of all types are to be avoided in surgery of bones and joints in forward areas.

No manipulation of the bone is done through the wound. Metallic fragments, debris (clothing, wood, etc.), and loose pieces of bone which are seen, are removed. If the missile is a large piece of metal, a search should be made just distal to it for a piece of clothing.

The '*late operation*', i.e., one in the presence of established infection, should be limited to enlargement of the wound and counter drainage

if necessary, but it is better avoided in a forward area.

Splinting.—This must fix the dressing and provide a reasonable degree of immobilization of the fracture until the patient reaches the Base. It must be simple, easy to apply, and easy to remove. It must not ' rub ' the patient and should require a minimum amount of attention during the patient's transit by M.A.C., ambulance train, etc.

UPPER LIMB.—

Shoulder and Humerus.—A plaster slab 6 in. wide is placed so that it extends from the nape of the neck down over the flexed elbow and up to the axilla. Small cuts are required in front and behind just above the elbow, so that the slab will lie flat when it is fixed round the arm with a few circular turns of bandage or plaster. This 'U' splinting is completed by the use of a narrow arm sling (collar and cuff) and no form of sling is placed round the elbow.

The plaster is most easily applied with the patient in a sitting position, should this be possible.

In severe arm injuries, such as loss of a few inches of the humerus, the ' U ' plaster is fixed to the chest by a few turns of plaster round chest and arm after placing a large pad between the arm plaster and chest. The hand is left free.

Elbow and Forearm: The elbow is placed at a right angle and the forearm supinated. A slab is placed on the back of the arm and forearm. Circular turns cover this from the axilla to the necks of the metacarpal bones. The plaster cast is split by one long incision down the anterior and flexor surface. A large arm sling is used.

Hand.—At this stage the splinting is to provide rest and comfort. A plaster slab is applied to the flexor surface of the forearm and over the palm of the hand, the wrist being dorsiflexed and fingers somewhat flexed at the metacarpophalangeal joints. The fingers must not be forced straight. This slab is bandaged into place by a cotton bandage, and the limb put in a large arm sling.

LOWER LIMB.—

Femur and Knee-joint.—At R.A.P. a Thomas splint, with or without the addition of small splints, should be used if facilities allow. Extension should be by metal clip or clove hitch. The boot-lace should be loosened and a small pad placed in the position of the tongue of the boot.

In the Field Ambulance a Thomas splint should be applied or adjusted if it has been put on at R.A.P. Clove-hitch extension should invariably be removed and extension made by adhesive strapping applied to the leg. The best type available is termed ' Bandage, plaster extension for treatment of fractures '. This is an elastoplast which can be stretched around the limb, but not in length. Prolonged extension by clove-hitch or any method of traction through the boot or a ' spat ' causes pressure sores around the ankle and over the heel.

In a Field Ambulance, *not* working as a Casualty Clearing Station, plaster-of-Paris should not be used as an adjunct to a Thomas splint in cases of gunshot wounds of thigh, knee, or leg complicated by fracture or joint injury, although its value *after* operation is known. If it is applied in simple fracture, only a few turns around splint and thigh should be employed. Some padding above the knee in front and below the tuber ischii behind is necessary. It must be appreciated that the thigh may swell before the patient reaches the Casualty Clearing Station.

In Casualty Clearing Stations and forward operating units, the use of plaster-of-Paris with a Thomas splint or Italian type of thigh splint has proved a great success from the point of view of efficiency and comfort. Plaster spica should not be used when the patient has to be transported soon after being wounded and operated on. Its application is a cause of increase of shock at this time, and during transport for long distances friction is inevitable and almost invariably causes pressure sores. Patients travel no more comfortably in a ' spica ' than in a Thomas splint with or without additions. It is difficult to put the patient having a ' spica ' on to a stretcher and impossible to put the stretcher into many of the recognized ambulance vehicles.

The details of the application of the two methods of applying the splints for gunshot wound of the thigh with fracture of the femur are :—

Type A: Apply plaster extension for treatment of fractures (*see above*) to leg and thigh if wound allows. The skin above the malleoli requires protection, preferably by adhesive felt. Cover the dressing and limb from groin to metatarsal necks with plaster-of-Paris bandages, keeping the knee flexed 10° and the foot at a right angle with the leg. Before this plaster is dry, the limb and cast are placed on slings attached to a Thomas splint. The extension bandage is tied to the end of the splint, one end passing over the longitudinal bar, the other under it, just beyond the foot. The ends are then carried to the notch at the end of the splint and tied under moderate tension, after the ring has been adjusted against the tuber ischii. The cast is split from end to end down the front of the limb and three bands of cotton bandages are tied round the cast.

Note 1: A simple method of opening the cast is by placing a length of rubber tubing down the front of the limb before the plaster is applied. The tubing is removed and a space left, into which the cutting edge portion of the plaster shears can be easily placed, immediately or at any stage of a journey.

Note 2: The extension bands must be placed direct on to the limb; a common mistake has been to place these between the layers of plaster-of-Paris. Traction on such an arrangement causes the plaster cast to press on to the foot so that sores arise.

Type B: Strapping extension is applied to the limb. The limb is placed on a Thomas splint and the extension bands tied. One pad is placed above the knee in front and another behind the thigh below the tuber ischii; plaster-of-Paris circular turns are taken around the thigh and splint. A cuff can be placed around the calf and splint after adequate padding, if desired.

Leg.—After the operation, plaster is applied from the mid-thigh or above to the metatarsal necks. The knee is flexed 10° and the foot is placed at a right angle; the plaster can be rested on slings and a Thomas splint.

Amputations will be considered subsequently.

2. At the Base

It has been indicated that the time taken for casualties to reach the Base varied at different periods.

Valuable information about the work done in forward areas was obtained from Surgical Divisional Officers at the end of 1941. The critical reports made it possible to inform the surgeons of errors of technique. At this time some surgeons were still practising primary suture after a wound excision, and these wounds were suppurating on reaching the Base, and the patient's condition was toxic. In a few cases corrugated rubber had been drawn through from wound of entry to that of exit and in some wholesale removal of bone fragments had been carried out. On the other hand, it was reported that the wounded who had had sulphonamide therapy were in better condition than those who had had no chemotherapy. Of 28 wounds of moderate severity treated by a surgeon in a forward area and given sulphanilamide, only 5 had a temperature of 100° or over after the first twenty-four hours.

One hospital reported that the casualties received had nearly all been transported by sea and had been subjected to much manhandling during evacuation, but their general condition on the whole was satisfactory. This was attributed to the intelligent use of plaster-of-Paris and the Thomas splint.

It was noted that, as a rule, the patients arriving in the earlier convoys from a battle were not in such good general condition, nor had as satisfactory a local condition, as those arriving by subsequent convoys.

There is no doubt that the treatment advocated under the description of the Forward Area surgery began to be practised during the Second Libyan battle (about Dec. 1, 1941). Improvement occurred during that month and continued during the next year.

Experience in the Base Hospitals showed that the casualties arriving there can be considered in three groups: (*a*) Those requiring immediate treatment for shock, hæmorrhage, etc.; (*b*) Those who have not had any operative procedure; (*c*) Those who have had an operative procedure and splinting.

Group b is practically non-existent except in battle periods. The type of operation to be employed is the enlargement of the wound and counter-drainage in some cases. Excision of the wound is not advisable. In other respects the treatment is such as is recommended for forward areas.

Group c. After one or more nights' rest, radiography is employed to discover if foreign bodies are in the limb and the nature of the fracture.

The Operative Procedure at the Base.—When an operation and splinting have been carried out in Forward Areas there is seldom any urgency for taking the patient to the operating theatre. A few cases require attention in twelve hours, but many can be left for a week or longer. The deciding factors are temperature, pain or discomfort, and the amount of discharge.

The plaster-of-Paris is removed, the limb is cleansed. The dressing is then removed and the skin around the wound cleansed. Surgical experience and judgement enables the operator to decide whether the wound should be enlarged, foreign body removed, or counter-drainage made. Large foreign bodies must be removed. As a general rule it is unwise to search for small ones as the opening up of tissue planes is undesirable and may be dangerous. Sulphanilamide powder is dusted over the wound and a vaseline gauze pack inserted. The limb is then splinted.

When patients arrive at the Base late (eight days or more) with infected wounds, closed plaster treatment is not indicated at that time, but may be made use of later on. The soldiers were more toxic and the wounds became clean slower under plaster. Hence irrigation or packs soaked in antiseptics were employed.

Mitchell (1942) was impressed by the use of proflavine powder, using from 0·5 g. to 2·0 g. according to the size of the wound, and Jack and Charnley employed eusol with success. It is certain that these methods of dressing the septic wound in the toxic patient have a place in the surgery at the Base and should not be discarded altogether. Hence if a wound complicated by fracture does not appear to improve when under treatment *at the Base* with vaseline pack and plaster-of-Paris the condition should be treated for a few days by irrigation and daily dressing. This treatment is not advocated until *three weeks* after wounding. Infection is most noticeable in large wounds (such as the thigh) when primary operation cannot be planned to remove the greater part of the tissue which was virtually infected. Infection spreads up fascial and intermuscular planes in this type of case. Irrigation may be helpful before resorting to further incision.

When a large wound is insufficiently drained a gravitation abscess is liable to occur when infection is not severe; serious infection of muscle and muscle planes may arise and may be complicated by secondary hæmorrhage. As so many methods of treating an infected wound are being

used with equally good results, no one method can be advocated.

Stress is laid on the preventive treatment of infection by carefully planned primary operation followed by limitation of dressing, and this primary operation can only be carried out in a Forward Area.

Oral sulphanilamide is continued if the wounded should reach the Base before completion of his prophylactic dosage.

Splinting at the Base.—

PRINCIPLES—In the selection of method the following points should be taken into consideration :—

1. The type chosen should be applicable for treatment until the fracture has united.

2. As anatomical alinement is desirable, the splinting must fix the whole length of the bone, and, in the lower limb, extension with support of the fracture is generally necessary. Fixation of the shoulder-joint or hip-joint is not necessary when extension is applied to the limb.

3. In grossly comminuted fractures due to gunshot wounds extension should not be employed to produce a limb of equal length to the other. Should this be done a central abscess cavity with sequestra is formed. Hence a degree of telescoping is desirable.

Lower Limb.—

Femur, mid-shaft and lower half: Skeletal traction by means of a pin or wire through the tibia at the level of the tubercle provides the best method of extension. The limb is placed in a Thomas splint to which are attached a leg extension piece and foot piece. This is suspended from a Balkan beam or similar overhead apparatus.

Femur, upper third: Fractures of this area are always difficult to treat when due to gunshot wounds. A posterior wound adds to the difficulty, and in many instances this is as large as 8 in. by 6 in., or there is a pelvic complication. Skeletal traction from the tibia should be used. There is usually advantage in placing strapping on the leg as well, so that extension is achieved both through the leg and thigh. Surgical judgment must decide whether it is sufficient to support the fracture by slings round the thigh suspended by pulleys from a Balkan beam, or whether a Hodgen or Thomas splint should be used as a support.

This type of case requires extension and support of the fracture by a pull in two directions ; complicated apparatus should not be used. A spica plaster is sometimes indicated, but if there is a constant flow of discharge from the top of the plaster on to the perineal area, secondary infection of the wound is inevitable. There is ample evidence that the organisms of the perineum do cause secondary infection of these wounds.

Braun's splint is used by some surgeons and they state that it is easy to use, but experience shows that most soldiers having this splint for fracture of the femur are uncomfortable and the femur unites with varus deformity. There are exceptions, as many fractures of the lower third of the femur are well treated on this splint. However, the use of a Thomas splint as originally intended or in an adapted manner is certainly preferable.

The weight to be employed in the case of fractured femur is learnt by experience and radiographic check assists the surgeon. Too great distraction is to be avoided as it is a cause of delayed union or non-union.

Balkan beams: The pattern made of wood and a number of steel tubes (fixed to the bed) was available. There were a few dozen Pearson fracture beds in Base hospitals. Universal Balkan beams were built into the wards of those hospitals where fractures of the femur were mostly segregated (*Fig.* 117).

Leg: Plaster-of-Paris is used from groin to metatarsal necks. A small amount of padding is advisable above the malleoli, and the inexperienced should cover the anterior border of the tibia. Adhesive felt, if available, is suitable. The plaster is usually applied by a posterior slab followed by circular turns.

It is not always advisable to employ extension in cases of gunshot wounds of the leg with fracture of the tibia, for fear of separating the fragments. When extension is required, skeletal traction through the heel is excellent, and the limb is rested on slings attached to Braun's frame.

Upper Limb.—

Humerus: 'U' plaster as described for use in forward areas, or two or three slabs around the arm, is used with the addition of a narrow arm sling (collar and cuff).

A shoulder spica is required in some cases, particularly when the head of the humerus and glenoid cavity are comminuted. This splint is uncomfortable in bed and for travelling, but the plaster spica with the arm abducted only 30° has no advantage over the 'U' plaster, is less comfortable, and takes longer to apply.

Elbow and Forearm: The same splinting is used as is advised for use in Forward Areas.

There was a sufficiency of apparatus and materials for good plaster work. Cellona was used in Forward Units and plaster-of-Paris rubbed into muslin (book no. 14) in Base Hospitals. Bandage methods were more popular than the 'creamed-fabric' method, in which muslin is cut to shape and soaked in plaster cream. When surgical appliances (callipers, leg irons, etc.) were required, they were made in a surgical appliance factory, where leather and metal were available. The tradesmen were Italian prisoners of war working under an N.C.O. of the R.A.O.C., with an orthopædic surgeon as technical adviser.

TREATMENT OF THE FRACTURED FEMUR DUE TO GUNSHOT WOUND

At the present time it is not possible to assess what number of these cases died from shock in Forward Areas. The reports of surgical teams show that few died in operating centres in Forward

Areas, unless there were multiple wounds. It is interesting to note that Marnham records that of 103 cases dying after operation in Tobruk, only 7 died from fractures, but it is not stated what number had fractures of the femur, nor how many of the 86 who had no operation had this injury. Thomas splints were carried in the outfit for regimental medical officers, so when circumstances allowed, this splint was applied soon after the wound was received.

The treatment in the Forward Area has been described. The limb, in plaster and with a Thomas splint, was fixed to a suspension bar on the stretcher for transport to the base. In an ambulance train these cases were sometimes left on a stretcher on the floor, and at others transferred to a cot and the splint tied to the cot.

The former is considered the best method for travel, but an air ring should be available. Fluid should be given freely and the patient not allowed to get cold. Treatment of shock and of the wound and immobilization of the limb for the journey are the essentials of treatment in the Forward Areas. If these have been carried out efficiently, it is unnecessary to proceed immediately with the treatment required at the Base.

After adequate rest and necessary investigation, such as radiography, blood-count, etc., the patient is anæsthetized, the plaster removed, and the wound inspected. Enlargement of the wound and division of fascia may be required, and any pieces of metal of moderate size are removed. If the wound is clean or moderately so, sulphanilamide powder is scattered over the surface and a vaseline gauze pack inserted. Should the wound be grossly infected, which was uncommon, an antiseptic pack would be put in. There were two different methods of splinting employed. The followers of H. O. Thomas employed adhesive strapping extension with the limb on a straight Thomas splint with a pad behind the knee. Others used skeletal traction, usually placing the thigh on slings on a Thomas splint, and the leg on an attached leg extension piece, so that the knee was flexed 30°. Sometimes a plaster cuff was placed round the thigh. Change of dressing was limited. In the earlier period it was carried out frequently, but after a time, when a bi-weekly dressing was done, it was appreciated that many wounds did not require change of dressing more often than once in three weeks. However, the infected wounds progressed better when irrigation or proflavine powder or eusol was used over a number of days.

As is to be expected, complications arose in a small proportion of cases. The large wound with fracture of the upper third of the femur is a difficult injury to treat. Secondary hæmorrhage is liable to occur and toxæmia is great if there is infection.

Progress varied, often for reasons for which it was difficult to account.

The treatment of these cases aims at getting the wound clean and healed as early as possible; extending the limb, so that the fragments are in apposition, but not separated by too great extension; maintaining this position; and mobility of the foot, ankle, and knee-joints when the bone has united.

The majority of cases were transferred to hospitals in South Africa some 10 to 12 weeks after the wound, but a number travelled much earlier. It is considered that the ideal is for union to be present to some extent before the transfer occurs. Major Eyre-Brook writes to say that sinuses were not present in more than 50 per cent of the cases under his care on a certain date.

When further information is available of the end-results of cases seen in the Middle East, a more detailed account will be recorded. Of nearly 200 cases of gunshot wounds of the thigh with fracture of the femur, 13 had amputation at the Base, of which 3 died. There were 9 additional deaths when no amputation was performed. Amputation was carried out on account of the patient's general condition, or for severe local infection or secondary hæmorrhage.

GUNSHOT WOUNDS OF JOINTS

The gravity of the wound penetrating or perforating a joint is not only due to the fact that if suppurative arthritis arises it may be followed by (*a*) fibrous ankylosis which is generally painful and tends to leave the joint in a position not the most serviceable for function, or (*b*) bony ankylosis, but that during the healing process the patient is exposed to the danger of septicæmia so that his limb and life are endangered.

It is not the intention to record the treatment of each joint, but the treatment of a gunshot wound of the knee-joint will be described as this is not uncommon, and can be taken as a standard treatment for most joints.

Suppurative arthritis is very serious if the patient has one or more wounds of moderate severity.

It is satisfactory to report that the amputation rate and mortality of the cases treated in the Middle East have been low.

The Knee-joint.—The joint should be immobilized by extension and the Thomas splint as soon as it is recognized that there is a joint injury. The operation in a Forward Area should be that of the wound. Surgical judgement must decide whether the synovial membrane should be closed and skin left open or whether the joint should be entirely left open. If extension has not already been applied, this is carried out by strapping. Plaster-of-Paris over the thigh and leg, and strapping extension is satisfactory; the limb and cast are placed on a Thomas splint and extension tied to the end of the splint.

At the Base.—Aspiration is most valuable in the sterile or mildly infected joint.

Strapping extension and splinting with the knee 10° short of full extension should be employed until it is quite certain that infection has ceased.

Plaster-of-Paris is good splinting, particularly if the limb and cast are rested in a Thomas splint.

Removal of foreign bodies from the joint cavity and when protruding into articular cartilage is advisable. When the wound is infected, it should be carried out at the Base, if not removed in the Forward Area. If aspiration shows that the joint is sterile, it is advisable to wait two or more weeks before removing a piece of metal from the joint. When a foreign body the size of a large pea is embedded in a condyle (not an uncommon occurrence), there is no urgency about its removal from a sterile knee.

When the joint is infected, decision has to be made as to whether aspiration, repeated several times, is likely to be successful in dealing with the infection. Many of these cases did not have a severe rise in temperature, although there was a purulent joint. Such knees may settle by repeated aspiration. However, when septicæmia or toxæmia is present so that the general condition is deteriorating, drainage by incision is advised. This should consist of two incisions (may be, one is an enlargement of an incision made in the primary operation); these should be placed laterally and extend from the suprapatellar pouch downwards and somewhat backwards, so that they cross the joint level slightly in front of the lateral ligaments.

They must open the suprapatellar pouch above and are valueless below if they are in the front of the joint. Incisions of 2 in. in length at the joint level are not effective. Posterior drainage should only be employed to drain an abscess in the popliteal space.

Irrigation is not advocated, except at the time when the incisions are made.

When there is prolonged suppuration, sequestra lying in a cavity communicating with the joint should be removed. It is uneconomical to remove sequestra from the patella when this bone is infected and sequestra are present in it. The patella should be removed even in the presence of sequestration.

Early movement of the joint in the straightforward non-suppurative case is encouraged. The date of commencement and extent of movement is controlled by the pain arising.

When ankylosis is expected, the knee should be kept straight, but not hyperextended.

When a patient is seriously ill with suppurative arthritis of this joint, decision has to be made as to whether amputation is advisable. The decision may be in the balance day by day and the results of the surgery of this condition in the Middle East are a credit to the discretion of the surgeons. It has been possible to investigate over 270 knee-joint wounds, of which 95 were suppurative; 12 amputations were performed, and there were 5 deaths from all causes. Full details will be published at a later date.

The Elbow-joint.—It is noticeable that the majority of these cases had considerable shattering of the bones of the joint. Frequently, the upper ends of the radius and ulna were destroyed with one condyle of the humerus. Primary wound treatment should be followed by placing the limb in plaster-of-Paris from axilla to metacarpal necks, the elbow lying at a right angle. There are advantages in the position of full supination being maintained at this stage of the treatment. Change of plaster should be limited. When the wound is grossly infected, antiseptic packs or irrigation through a window have been followed by rapid improvement of the condition. The tendency for the septic wound and surrounding tissue to swell out through a window exists, but no splinting is as comfortable or effective as the plaster for this joint. Furthermore, this treatment should only be employed for a few days, to be followed by a new complete plaster or closure of the windows, so that the plaster level over the wounds is on the same plane as the forearm and arm. In a series of 51 cases, which present many interesting features, there were only 2 amputations and 1 death, in a man who had multiple wounds. There were 12 associated nerve injuries.

Study is being made of the value of excision in Forward Areas, and on the flail elbow and other end-results, which are complicated by the peripheral nerve lesion.

MOVEMENT OF JOINTS IN GUNSHOT WOUNDS OF THE LIMBS

When anyone has a fractured limb, his thoughts are read by the questions he asks: will the bone join? and will the limb be short? Rarely does he ask if a neighbouring joint will be stiff, but if he is told he has a joint injury, his first inquiry is regarding the ultimate movement he will get. Hence, it is advisable to explain to the wounded soldier that his co-operation in the movement of his joints is essential to prevent stiffness and regain movement.

In the Middle East there were two lines of treatment adopted for regaining knee-joint movement in fractures of the femur. Those treating the fracture by Thomas's method did not allow knee-joint movement until there was clinical union. Those whose fractures were treated by skeletal traction, or by strapping extension with a Thomas splint (and usually leg extension piece) had early movement. The patella was moved from side to side passively straight away and passive knee-joint movement started within the first week, unless it caused pain, and active movement as soon as the patient could manage it. The soldier was encouraged to work his own passive movement by cord and pulleys attached to the leg extension piece. Immediate active movement of foot and ankle were routine whichever method of treatment was employed. Foot supports of one kind or another were in constant use. It is worthy of notice that if a sling of strapping or bandage is fixed to the sole of the foot and carried up by a cord and pulley to a weight, this sling must be "spread at the

metatarsal necks or beyond the toes, or else, in a number of patients who are recumbent for weeks, hyperextension of the four outer metatarsophalangeal joints will develop, and unless the sling supports the big toe there will be a hallux flexus." It should be part of the treatment that the toe joints are put through a full range of movement passively every day.

It has not yet been possible to ascertain which method of treatment to prevent joint stiffness is the better. However, there is evidence that many patients have a smaller range of movement at the knee two to three weeks after walking has commenced than they had in bed. Also bed patients lost movement during transit by ship to South Africa if active movement was neglected during this period.

The reports from South Africa regarding knee-joint movement are most discouraging, as few of the fractured femur cases had 90° of movement some six months after being wounded, and the majority had only 40°. The wearing of a calliper is one cause of the ' setback ' in the range of movement. There is scope for investigation of the best method for regaining joint movement.

It is an unsettled problem when movement should be commenced after a gunshot wound of the knee-joint when some degree of mobility is expected. The general principle followed has been to start active movement a week or so after all symptoms, including pain, have disappeared. Spasm is a contra-indication to encouragement of movement. It is important to keep the ankle and foot moving throughout the treatment.

In all lower limb wounds suppuration in muscle planes, particularly along the outer side of the thigh, delays movement of the knee-joint.

In the upper limb too much stress cannot be laid on the care of the hand. If splinting is required, every effort should be made to leave the fingers free and arrange the splint so that a full range is possible at the metacarpophalangeal joints. The fingers must never be splinted in full extension, and hyperextension at the knuckle-joints will lead to impaired function. The limb should be kept raised as far as possible, as once the fingers become swollen it may be difficult to get rid of the swelling; it is far more difficult for a patient to move fingers which are swollen and those which have been swollen, than it is when they have been free and supple ever since he was wounded. If early movement is encouraged, it is probable that this will limit swelling and undoubtedly it saves the patient and masseur much worry later on.

There is ample evidence that early finger movement with the wrist dorsiflexed 45° is of value, and it is hoped that baths, heat, and massage for hands will become a forgotten form of therapy.

AMPUTATIONS

Surgeons have had the opportunity of reading standard pamphlets on this subject, particularly the one published by the Medical Research Council (1941). In every theatre of war matters arise which are of local importance, but frequently lessons can be learnt from these which prove of value elsewhere. In the Middle East lessons were learnt from mistakes made in connexion with amputations. These came to light from reports of surgeons at the Base and at the Surgical Conference, 1942, so ably organized by Maj.-Gen. D. C. Monro.

At this Conference Colonel Stout, Consulting Surgeon to the 2nd N.Z.E.F., expressed clearly and concisely his opinion on emergency amputations, and all surgeons appreciated his words of wisdom.

The indications for primary amputation—that is, on or about the first day—are quite straightforward and generally agreed upon. At a later date the decision is more difficult, particularly when it is contemplated owing to infection. Septic absorption is less from the upper than lower limb, and delay in amputation of the upper is a risk to take.

When there is secondary hæmorrhage, proximal ligation is correct, whereas a second large hæmorrhage (particularly in the thigh) is an indication for amputation.

Sites of election do not exist in war surgery. The necessity for saving every possible inch of limb on amputation must be the basic principle, but this does not mean that a Syme's amputation is indicated for a severe foot wound. In the upper limb, a few stumps of thumb and fingers are better than the best prosthesis.

Early and continued skin traction has proved of value, but can seldom be commenced before the patient reaches the base.

It was agreed in the Middle East that the guillotine operation is rarely indicated. Some skin-flaps can usually be cut. The alternatives in the Forward Area are to stitch the flaps back or to drop them over the end of the stump. The former method was practised by the New Zealand surgeons, and some of the surgeons at Base hospitals commented on the healthy condition of the stump. I consider this the method of choice, but it has not been employed by many of our surgeons. The flaps are dropped over the end of the stump, usually without secondary suture in 5 to 8 days. If the second method is employed, the stump can be covered with sulphanilamide powder or other antiseptic and two or three stitches put in. No rubber drainage tube is of value. If the skin edges are approximated by suture to close the wound except for lateral drainage (i.e., primary closure) there will be pain, due to tension and retention of pus.

Stumps and dressings should not be covered by plaster-of-Paris bandages in forward areas.

At the Base it is sometimes necessary to amputate through infected tissue. Closure of the wound is not advisable. Secondary suture in 10 days or so is highly satisfactory.

This record of facts, historical and clinical, has been possible owing to personal notes and access to many reports. The constant assistance of Maj.-Gen. Sir P. S. Tomlinson and Maj.-Gen. D. C. Monro enabled me to keep in close contact with all the units in which surgery of the moment was being carried out, and to have access to reports. I wish to express my thanks to them and to the many divisional officers and surgeons with whom I had the privilege of working. Their co-operation in clinical work and in collecting series of cases was undoubtedly a factor in enabling all surgeons to benefit by experience.

The work of the A.I.F. and N.Z.E.F. Medical Services was side by side with our own, and I thank both Colonel Hales and Colonel Stout for providing me with material, of which use has been made in this paper.

My association with many has made sifting of material possible, and if opinions I have expressed are not approved by all my colleagues, it is hoped that it is a fair record and critical review of the surgical work, particularly of bones and joints, in the Middle East during 1941 and the first half of 1942.

REFERENCES

Lancet, 1942, **2**, 416.

Emergency Amputations, M.R.C. War Wounds Committee, 1941. H.M. Stationery Office.

THE AETIOLOGY OF APPENDICITIS*

By W. H. BOWEN, Cambridge

In the first place I propose to deal with certain conditions which have been considered aetiological factors in acute appendicitis. These are constipation, kinks and bends, vulnerability of the blood-supply, and threadworms.

Constipation.—This can be completely eliminated. In the majority of cases of acute appendicitis the patient will give the history that his bowels have been perfectly regular. Taking 40 consecutive cases of acute appendicitis, regularity of bowel action was found in 32 cases (80 per cent), constipation in 8 cases. Constipation as a factor has often been attributed to stagnation of fæces in the appendix from back pressure in a loaded cæcum. A loaded cæcum is very rare at operation. Examination in most cases gives the impression of emptiness save for gas. Hurst also pointed this out many years ago.

Of the 8 cases of constipation, in 5 the lumen of the appendix was empty, in 2 a small and insignificant quantity of mucus or muco-fæculent material was present, and 1 case was obstructive with a stercolith.

That mere stagnation is not sufficient is shown in two cases of ring carcinoma of the ascending colon just above the cæcum, where from chronic obstruction the cæcum and neighbouring small bowel were dilated and hypertrophied. The appendix was also distended throughout, but quite empty and normal. Again I had the opportunity some years ago of seeing a post-mortem examination on a man who suffered from megacolon with a girth of 45 inches. The whole of the large intestine from cæcum to the pelvirectal juncture was dilated and tortuous, as were also the ureters. The appendix was normal. The work of Sadyoun and Oppenheimer, to which reference will be made later, supports these clinical facts.

Fixation of the Appendix by Adhesions, 'Bands', and in Fossæ, and the Presence of Kinks in Some Part of Its Length.—No attempt will be made to deal with anatomical detail. The data given here are based on operative work supplemented by a much smaller experience at autopsies on all sorts of cases. In a majority of cases at operation the cæcum, lower ileum, and appendix can be brought out of the abdomen because of their mobility. In some cases the cæcum is fixed in the right iliac fossa, so that it cannot be pulled up to the surface and removal of the appendix has to be done within the abdominal cavity. This does not mean that the appendix is fixed, for it usually is not and its removal is simple. In many cases where plastic peritonitis has set in it is quite easy to free the appendix of the recent adhesions; when this is done the parts involved are easily brought out and dealt with. On the other hand, the worse cases we have to deal with have gone beyond any anatomical survey owing to abscess formation; but I hope to bring evidence later that the main aetiological factor in these cases is the stercolith and not fixation. The point I wish to make here is that pronounced fixation of the diseased appendix is uncommon.

A discrimination must be made between acquired adhesions, the outcome of previous disease, and adhesions which there is every reason to believe are congenital in origin. The capacity for resolution and a return to the normal of the peritoneal lining of the abdominal cavity and its contents is now generally recognized. Most surgeons must have been impressed by this, especially where, after the opening of an appendical abscess, appendicectomy has been done at

* A Hunterian Lecture given at the Royal College of Surgeons on April 5, 1943.

some later date. Firm bands have been noticeable by their absence. This point is dwelt upon in order to emphasize the fact that acquired adhesions are seldom in the nature of firm bands, but are usually fine, filmy, and on the whole characteristic. They are usually easily differentiated from congenital ones.

The commonest types of fixation of the appendix, congenital in origin, are the following :—

1. *Retrocæcal*, which is either complete, so that in the extreme case the whole length of the appendix may appear to be buried in the cæcum, or partial, where the distal part is free, and in many cases has a bend at the juncture of the free and attached portions. At times this bend may be very pronounced and approximate to a kink when seen at operation. This is, however, more apparent than real, and probably due to the paralysis produced by anæsthesia. It can usually be straightened out sufficiently to show that there is no real kink. Also in cases of retrocæcal appendix there is no sharp bend at the attachment of the appendix to the cæcum which could hold back any contents. This point can be verified in the post-mortem room. A ' whorled ' appendix (a congenital spiral twist) is of no significance.

Occasionally a retrocæcal appendix will have its distal part ensheathed in what appears to be a peritoneal fossa. This fossa is " the result of the adherence of two normal endothelial surfaces " to quote Reid (1914), who states that this is not a theory but a truth. He found evidence of such fusion in almost every fœtus he examined. Such a fossa is congenital in origin. Often the distal part of this ensheathed appendix is attenuated.

2. *Adhesions to the Mesentery*.—These are commonly found. They are attachments of the meso-appendix to the under surface of the mesentery at the lower end of the ileum. Reid notes such an attachment in the fœtus and attributes it to fusion of the meso-appendix and the genito-mesenteric fold. It is seldom of any significance surgically and is evidently negligible in limiting the movements of the normal appendix.

3. *Fixation by a Band to the Iliac Fossa*.—A firm band fixes the antimesenteric border of the appendix about the middle of its length to the iliac fossa. It may lead to distinct bending or even kinking at the point of attachment. An attachment of the meso-appendix to the iliac fossa may also be seen, but it is much rarer.

4. *Fixation in a Tunnel in the Pelvis*.—The appendix passes down to the pelvis, is attached to the posterior abdominal wall, and may be fixed in a tunnel of peritoneum at the terminal part. Surgically these are the most difficult cases for removal, as the appendix may go as far as the iliac vessels. The attachment is probably along the genito-mesenteric fold (Reid, 1914), and this fossa formation is due to the same cause as in the retrocæcal condition already mentioned. This condition is the least common of the four.

They are all congenital, for they are found in the fœtus at all ages. The absence of a history of former attacks and of any other signs of previous disease in many cases supports the view that they are not the result of a past appendicitis. I do not think they play any part in the aetiology of appendicitis except perhaps in cases of severe kinking, which is very rare. This may possibly interfere with the blood or lymph supply or lead to stagnation of contents. I have been unable to convince myself that either supposition is proved. Examination of many cases of these anatomical variations has shown that they are no more likely to be associated with stagnation in the appendix than other simpler anatomical types. They may be placed in the same category, I think, as other twists and bends of the bowel which may appear to produce kinking of the lumen. I have seen many of these anatomical peculiarities unassociated with constipation and am convinced that they play little, if any, part in holding up the bowel contents.

In the discussion on alimentary toxæmia at the Royal Society of Medicine one speaker attributed stagnation and stercolith formation to evolutionary bands produced by chronic constipation. Reid's anatomical researches and Hurst's clinical and roentgenological work negative such a view, and the evidence I have brought forward with reference to constipation and appendicitis is against such bands being the result of, or contributing to, constipation.

To sum up, stagnation in the appendix may as often be seen where no bands, adhesions, or kinks are present, as in cases where they are. The consensus of opinion now is, I believe, that these adhesions are congenital and not acquired, and the onset of appendicitis, after many years of apparently healthy life without history of constipation, is against their being important factors in the aetiology.

Vulnerability of the Blood-supply to the Appendix.—This is mainly an anatomical problem. Koster and Weintrob (1928) in their work on the blood-supply to the appendix point out that the arterial tree is remarkably constant; they comment upon the richness and profuseness of the anastomosis and show that the blood-supply is arranged in two layers, of which the richer is the deeper. The corkscrew and spiral character of the appendicular branches is noteworthy from the secondary ones onwards. It is clear from their work that interference with nutrition through twists, bends, and kinks is negligible. Seng, working in Aschoff's laboratory, supports this view.

Behan (1921) found that tying the vessels in the meso-appendix led to no gross changes owing to the satisfactory collateral circulation. He supports what I think is the general surgical opinion that the nutritional changes follow an inflammatory process in the mucous membrane and submucous tissues. Now and again in operating, by puncturing the vessels with a transfixion needle or by the slipping of forceps, the integrity of vessels in the meso-appendix will be demonstrated even where the appendix is extensively

gangrenous. On the other hand, in rare cases thrombosis of the appendical mesenteric vessel does occur, for the mesentery is sometimes friable and breaks away without any hæmorrhage taking place. It happens only with extensive gangrene, and this suggests that the thrombosis in the mesentery is a terminal process.

Another point worth mentioning is that in cases of kinks and bends one does not in practice see any engorgement or signs of stagnation in the part beyond the bend or kink, or any strong contrast between that and the parts proximal. Sometimes, however, the end is bulbous. This is usually due to the thickening of the submucous layer which may occur as the result of obstruction to the lymphatic or venous return ; but it closely simulates the condition found in chronic appendicitis and in cases with a history of a previous attack of acute appendicitis which has subsided. It seems justifiable to sum up by saying that there is no evidence that the gross anatomical arrangements of the appendix predispose to acute appendicitis or, indeed, to any form of appendicitis.

Threadworms.—I think it will be conceded by most surgeons that threadworms are certainly not aetiological factors in either acute or chronic appendicitis. Fischer (1921) states that in China, where intestinal parasites are widespread, appendicitis is relatively unknown. In young children in whom threadworms are most common the disease is comparatively rare. Eastwood (1923) states that in the post-mortem room threadworms were found in the same proportion of diseased as of normal appendices. My experience in some hundreds of cases of appendicitis was that their presence was rare. They were not always separately and carefully looked for, but the whole lumen was methodically inspected and records kept. Exact figures cannot be given, but it is fully justifiable to say that they were not more than 1 per cent.

The possible explanations of the causation of appendicitis would seem to resolve themselves into three :—

1. By an infection from the main bowel (enterogenous).
2. By infection through the blood-stream (hæmatogenous).
3. By infection from within its own lumen (which may be called intrinsic).

1. ENTEROGENOUS ORIGIN

In favour of this origin one may argue that some poison, bacterial or chemical, spreads from the main bowel, damaging the mucous membrane of the appendix and so starting the pathological changes. We can well conceive that such a factor might be harmless in the bowel with its large lumen and yet harmful in the narrow compass of the appendix. This narrow space would soon be further curtailed by swelling of the mucous coat. Later on the involvement of the muscular coats would lessen the chances of the clearance of accumulated exudation, whilst the presence of a stercolith might produce ulceration by pressure and intensify the inflammation present. Such a view would seem the common-sense way of looking at the problem. We have an argument in its favour in other cases of infection of retained secretion or excretion.

In a few cases of acute appendicitis in both children and adults the attack is associated with diarrhœa, which, however, is *synchronous* with the onset. More rarely still there is a history of some gastric upset in some other member of the family. The latter cases, however, require careful sifting of evidence before credence is to be attached to such history. They are certainly rare and often the history of a previous attack may prove this to be but a coincidence. This inquiry into history is important in such cases.

Against an extension from the bowel are :—

1. The absence in the vast majority of cases of all history of a preceding or concomitant ileocolitis and the absence of any diarrhœa or passage of mucus.

2. Small children are most liable to diarrhœa and intestinal infection. Yet (*a*) in the young, appendicitis is relatively infrequent, (*b*) when they get it the history of gastro-entero-colitis of any sort is usually lacking, (*c*) in summer months, when the possibility of food contamination is greatest and childish diarrhœa in consequence not uncommon, appendicitis is no more frequent than at other times, but rather the contrary.

3. It is noticeable that well-known infective conditions of the bowel, such as typhoid and dysentery, are not complicated by appendicitis. MacLean found acute appendicitis rarely occurred as a complication of intestinal catarrh, dysentery, or influenza. Hurst quotes some French statistics which show that no single case of appendicitis occurred among 640 patients suffering from mucomembranous colitis.

4. It is a striking fact that if a number of appendices removed for acute appendicitis are opened and examined there will be found cases of disease of every grade from mild to severe in the distal part of the appendix, whereas the proximal mucous membrane is often but little affected. This was also noted by Aschoff (1920). If the disease spreads from the large bowel we should expect the opposite condition to be found.

2. HÆMATOGENOUS ORIGIN

There are two theories to be considered under this head : (1) That of the selective affinity of organisms brought forward by Rosenow (1915) of the Mayo Clinic, based on bacteriological work. (2) That of Lansdown and Williamson (1914–15) based on microscopical studies. Here, whilst the origin is not thought to be organisms from the blood-stream, it is deep to a barrier of epithelium, and, one would infer, is at least nutritional or chemical in origin and dependent upon the blood flowing to the part.

I propose briefly to consider these theories :—

1. Rosenow isolated the organisms in cases of appendicitis and of pus from diseased tonsils and injected them into a vein in rabbits. The selective affinity was demonstrated, but there seems to be no reason to suppose that it is what occurs in the human subject in cases of appendicitis. It seems clear that what he is dealing with is a septicæmia. The rabbits after injection were often found dead and the lesion of the appendix did not appear, in most cases, to be sufficient to explain death. Again, in many cases, there were lesions of other parts. Joints, stomach, duodenum, Peyer's patches, kidney, muscles, and the endocardium were not infrequently involved. It would not be surprising that bacteria, which in the first place had attacked lymphoid tissue, which is very pronounced in both tonsils and appendix, when injected into the blood-stream should attack similar structures. This seems a reasonable way of explaining these experiments.

There is a great deal of literature on the bacteriology of appendicitis. I make no endeavour to epitomize it, but would refer those interested to Aschoff's book. I shall refer to that work later, but the point to be stressed here, and in connexion with any hæmatogenous theory, is that Aschoff has shown that the organisms which he believes cause appendicitis are present in practically every normal appendix from the very earliest years—if not months.

Aschoff (1931), in one of his communications entitled " Appendicitis and Angina," points out that the principal organisms present in the tonsil and the appendix, both in health and disease, are different—in the tonsil a hæmolytic streptococcus ; in the appendix a non-hæmolytic streptococcus, which French bacteriologists have isolated and differentiated as enterococci. He furthermore discusses the possibility of the one being transformed into the other. He believes that it is extremely improbable that this can take place in the blood-stream or during transit in the small bowel.

A weak spot in this theory and all theories based on a hæmatogenous origin is that it presupposes an antecedent focus. My experience is that most attacks of acute appendicitis are lacking in any history of immediate preceding illness ; usually they are sudden and quite inexplicable ; there is no history of tonsillitis as a precursor, and they but rarely follow measles or scarlet fever or any other form of illness. When patients get streptococcal lesions elsewhere or a generalized septicæmia, appendicitis is unknown as a complication.

In one of his papers Rosenow concluded a summary as follows : " Finally, it may be pointed out that the frequent occurrence of appendicitis, at times almost in epidemic form when throat infections are particularly prevalent, is now easily understood." I have examined several years' statistics of appendicitis and never found any suggestion of an epidemic character. In the autumn of 1932 an epidemic of infective pharyngitis and to a lesser degree tonsillitis was widespread. The number of cases of appendicitis for this period was strictly within the average of other years.

2. The paper of Lansdown and Williamson is an attempt to bring the inflammatory lesions of the gastro-intestinal tract within a single pathological concept. Briefly stated, their theory is based upon changes which occur in certain solitary (lymphoid) follicles which lie in the submucous tissue immediately underneath the mucous membrane and internal to the muscularis mucosæ. These solitary follicles, so pronounced a feature of the appendix, are also found in the stomach and intestine. They disappear after the age of 40.

In appendicitis and gastric ulcer the following changes in these follicles are described : (1) hyperplasia, (2) necrosis without involvement of the overlying epithelium, (3) necrosis with ulceration due to destruction of the overlying epithelium, which is said to fill the lumen with debris. The work is based on the examination of 211 appendices removed either from cases of appendicitis or gastric ulcer. The authors point out that these changes, when unassociated with superadded sepsis, explain the condition found in chronic appendicitis, such as stenosis and obliteration of the lumen which are limited to the mucous and submucous tissues. In comparing their pathological picture with that, for instance, of Dudgeon and Mitchener (1924), one has to remember that Lansdown and Williamson are dealing with what they consider the very earliest manifestations of the disease and they do recognize a later stage, which they attribute to secondary sepsis where all the coats are involved.

In discussing the clinical picture they state that the patient has suffered for some years from bilious attacks and that habits of constipation appear to develop from about the period of the first attack. Between the attacks the patient has some degree of indigestion. This clinical picture of bilious attacks, constipation, and flatulent dyspepsia is not borne out in the analysis of a large number of cases, keeping these diagnostic points of view. My experience is that chronic appendicitis is usually manifested as a pain in the right side associated sometimes with nausea, often with a furred tongue and very little else. Only the long persistence and its influence on work or peace of mind justify operative interference, with the patient's agreement, and after the uncertainty of results has been stated. Biliousness and bilious attacks may be early phases of appendical trouble, and cases of bilious attacks free from pain passing on to those with pain and finally typical clinical appendicitis can be recognized. Such cases are rare. On the whole the same can be said of constipation and even more definitely of flatulent dyspepsia. Clinically, giving a personal opinion, I should say that the nearer the clinical picture approaches the acute attack the more likely the appendix is to show

definite pathological changes which are unequivocal. These are cases where the clinical picture is so hazy and indefinite, the pathological picture so uncertain, that time alone can show the correctness of the diagnosis by the relief of symptoms following removal. I published a series of these cases several years ago and feel that there is no reason to go back on the conclusions formulated then. They are far from supporting the clinical picture of Lansdown and Williamson.

Before considering the theory of Lansdown and Williamson, there are two criticisms of the microscopical picture upon which the theory is based which should not be overlooked. In the first place, it depends upon relatively small changes in the solitary follicles. The question must arise whether such changes might not be the result of damage to the preparation either in the removal of the appendix or in its preparation for section, especially the former. In the manipulations of the appendix at the time of operation, especially where this presents any difficulty, considerable handling and pressure may be unavoidable, and even if avoidable the importance of care in handling may not have been pointed out. I have discussed this with technical experts who agree that it is a pertinent criticism. This point is not considered in the original paper.

The second point is that Aschoff (in criticism of some theory brought forward by another German worker, Banhin, in the same field of inquiry) states: "I do not consider it worth while discussing his curious views concerning the origin of the disease in an ulceration of the follicles for there is no original microscopical or other evidence in support of such opinions." As microscopical anatomy was Aschoff's peculiar province, it is impossible to ignore this finality of statement.

Criticizing the theory itself:—

1. With such changes in these solitary follicles one might reasonably expect to find not only microscopical ulceration, which they describe, but macroscopical ulceration. This is rare. Ulceration of the appendix does occur, but it is very uncommon. It is usually a rapid process associated with a necrotic base, quickly involves the deeper coats, and is often a prelude to perforation.

On the other hand, tiny, but macroscopically visible, red points in the mucous membrane are often to be seen, and these may be small points of ulceration only capable of demonstration by a magnifying lens. I have always looked upon these tiny areas as surface hæmorrhages preceding a further stage of definite and more extensive hæmorrhages, which in turn may result in thrombosis, necrosis, and gangrene.

2. To explain the diffuse catarrh of the appendix from cæcal opening to tip, which may be found, one would have to suppose solitary follicles being attacked over a large area at the same time. This, however, does not negative the theory, for we have no knowledge of the aetiology of the follicular changes. The localization of the inflammation to the distal part of the appendix is also difficult to explain.

3. The disappearance of the solitary follicles at 40 is against the explanation of both gastric ulcer and appendicitis in older people, especially very old people. I have notes of two patients who developed appendicitis at the age of 80. Both were highly intelligent men and were sure that they had had no similar attack before.

It is interesting to note that Lansdown and Williamson describe the lumen of the appendix as filled with debris once the mucous membrane gives way. Macroscopically on cutting up the appendix after removal it was empty, save for insignificant amounts of mucus or mucofæculent material, in 20 out of 30 consecutive cases examined. This seems a contradiction until an examination of a section of such an appendix is seen under the microscope. There is then seen a filling of the lumen as pointed out by Lansdown and Williamson which has its counterpart macroscopically in the mucus adherent to the wall. This adherent mucus gives the glistening appearance so characteristic of an early phase of acute appendicitis.

Before turning to the third possibility I propose to discuss: (*a*) The stercolith; (*b*) Its influence on the severity of the disease.

a. **The Stercolith.**—Shattock (1916) showed that the stercolith was formed from fæcal material; that it consisted almost exclusively of the residue of disintegrating vegetable tissue; and that in their essential nature scybala and concretions (stercoliths) are closely akin. The fact that every phase of fæcal collection is found, from soft solid to scybalous masses and so to the stercolith, gives clear evidence as to their origin. He also showed that no foreign body formed the nucleus of the concretions. He attributed their formation to some form of appendicular stasis and recognized that the local fault may be neuromuscular or mechanical. An explanation of the reason for a neuromuscular inco-ordination will be dealt with later.

The stercolith does not usually block the lumen of the appendix entirely. It can sometimes be pressed into the cæcum *in vivo* even where it lies beyond what can only be described as an obvious kink. The musculature of the wall is not at fault. Harris, Cox, and Blacklock (1930) brought the appendix of the dog outside the abdomen under observation. Any efforts to block the lumen with foreign bodies were unsuccessful. The musculature forced them out. In most cases if gangrene has not set in the appendix will contract down after removal. This can easily be demonstrated. In some cases appendical contents will be squeezed out. This effect, however, is slight, but cutting up the appendix is invariably followed by marked contraction in the longitudinal direction even in cases where fæcal accumulations completely filled it. This

shows that it is not the contractile power of the muscle which is at fault.

Thus it seems clear that the failure of the stercolith, whether in its developing or matured form, to return to the cæcum cannot be ascribed to loss of power on the part of the muscle of the appendix. The failure lies elsewhere.

Here reference may be made to one point which perhaps has a bearing on this problem. In a number of cases of obstructive appendicitis the obstruction is not due to blocking by a stercolith or stenosis from former disease. If the appendix is cut up after removal it is impossible to give any reason for the obstruction. This is strongly suggestive that the obstruction is caused by some paralysis of the musculature or by the spasm of the fibres proximal to the stercolith.

Obstructive appendicitis without an obvious block does not always involve the whole length of the appendix, though in some it affects all but the extreme cæcal end. Obstructive appendicitis often involves only a part of the appendix. This suggests that it is not due to any sphincter action. If we concede this point we have a factor present which may play a part in retention and inspissation of the fæces in the appendix.

One point will, I am sure, have occurred to all: if obstructive appendicitis is due to spasm, this spasm should disappear under anæsthesia and the obstruction be relieved. There may be cases where this is so, but in some cases the obstruction persists. I would like, however, to emphasize the fact that in some cases of obstructive appendicitis no cause for the obstruction can be found after removal, and that if it is not due to spasm it is difficult to say to what it is due.

b. **The Influence of the Stercolith on the Severity of the Disease.**—I propose to analyse the 150 cases of acute appendicitis admitted to Addenbrooke's Hospital in 1932.

They are classified as follows: (1) The catarrhal types where no necrosis has resulted, but where there is congestion, œdema, and, in some cases, hæmorrhage into one or more coats. (2) The cases where gangrene has occurred in one or more coats but usually in all, generally more or less locally, occasionally quite locally as a perforation. (3) The obstructive type accounts for the remainder, but with these I do not intend to proceed further here.

1. The catarrhal cases—61 in all.

a. Stercolith present in lumen—3 cases.

b. No stercolith present in lumen—49 cases.

c. No stercolith present in lumen, but some fæcal matter—9 cases.

In 95 per cent of the cases of catarrhal appendicitis there is no stercolith.

2. Cases with gangrene—69 in all. Six cases are excluded as the data were insufficient to give an opinion on the presence or absence of a stercolith. In 63 cases:—

a. Stercolith present in lumen—40 cases.

b. No stercolith in lumen—18 cases.

c. No stercolith present in lumen but some fæcal matter—5 cases.

In just over 63 per cent of cases of gangrene a stercolith was present.

Type of Appendicitis	No. of Cases	Stercolith Present	No Stercolith
Catarrhal (Mild)	61	3 (5 per cent)	58 (95 per cent)
Gangrene (Severe)	63	40 (63 per cent)	23 (37 per cent)

Obstructive appendicitis not considered here.

It is clear from these figures that one important factor in the severe grades of appendicitis is the stercolith.

3. INTRINSIC SUSCEPTIBILITY

Having dealt with these points, it is now appropriate to consider the third possibility. It does not require, however, much consideration to see that where a layer of lymphoid tissue is only separated from a highly infected narrow tube by a single layer of epithelium, the chances of infection are considerable. It is easy to understand the menace of the stercolith and the significance of the changes set up in obstructive appendicitis. In both we may say there is combined the trauma of pressure with a concentrated bacterial flora. We can understand the majority of cases of acute appendicitis as being due to local vulnerability. The frail barrier of protection is overcome by the foreign body or as the result of pressure from obstruction.

There remain, however, the large number of cases where acute appendicitis occurs without either stercolith or obstruction. We have still to inquire what factor sets up the acute inflammatory process in these cases. The final decision, if it can be made, must decide the real cause of appendicitis in its simplest form, for there is no reason to suppose that the more serious varieties, such as the gangrenous, perforated, and even obstructive, have any differing aetiology. We can start with the probability that all forms have a common origin and this has been the opinion of most of those who have seriously considered the problem. Superimposed septic infections due to special conditions explain the virulent forms, and, equally probable, a weakly infection or a powerful phagocytic protective reaction explains the chronic and subacute ones.

Aschoff has been the foremost worker who has formulated the idea of an intrinsic origin of the disease. He has shown that the disease starts as an infective catarrh of the mucous membrane. "It begins," he writes, "with a superficial lesion of the epithelium and the formation of a plug of leucocytes in one of the folds of the mucous membrane, usually in the distal segment of the organ." There is little doubt that this is the beginning of the inflammatory process. Clinical experience bears it out. Every grade can be seen in diseased appendices from a local mild congestion of the mucous membrane to the most profound changes such as perforation and gangrene, usually in the distal part. There is no need to

follow up this sequence, as once it has started as an inflammation of the mucous membrane we have localized the site, but there are a few further points to be considered. We should like, if possible, to know whence these organisms come, and what are the factors which lead up to their pathogenic activity?

Aschoff's contention is that the appendix develops a bacterial flora peculiar to itself. The farther away from the cæcum the more distinct the difference, until at the tip, in the absence of fæces, the differentiation is complete. He maintains that it is this distinct and definite flora which is the infecting agent in appendicitis. To agree to this, he points out, it is necessary to believe that the appendix does not become regularly filled with fæces, and he assumes that the appendix fills only at irregular intervals, and often incompletely in ordinary physiological conditions. He also points out that appendicitis usually begins in the most distal part of the organ and that the same organisms are grown from the healthy as from the diseased appendix. He mentions that here we have a close parallel with the tonsil and that it is comparable with the presence in the mouth of healthy people of streptococci and pneumococci. Aschoff finally declares that we are dealing with an increase of virulence on the part of organisms which are probably in the appendix from childhood onwards.

There is no need to go into any detail of the bacterial flora of the appendix as set out in Aschoff's book beyond noting that it comprises in its final summary a number of organisms of which some, especially the enterococci and the B.C.C., are common to the cæcum. You will note that the differentiation and segregation from the cæcum is attributed to the absence or relative absence of fæces from the appendix. Even if fæces entered the appendix regularly, which I think Aschoff realized was difficult to disprove and physiologically probable, he supported his hypothesis by another one of "self-cleansing", whereby some secretion from the appendix prevents the growth of any but the special bacteria. His evidence that the organisms he names are the cause of the disease is founded on the demonstration of phagocytosis of these organisms in stained smears of pus taken from the lumen; by sections of the appendix demonstrating those bacteria which undergo phagocytosis and those which do not; and, finally, the cultures of organisms in cases of appendicitis. He points out that the method of approach is all that is possible since demonstration by Koch's law or agglutination tests is impossible.

I think everyone will agree with Aschoff that in the absence of a proximal stercolith the disease is usually most pronounced in the distal part.

But his contention that the appendix does not become filled with fæces is a different matter. A valuable paper by Sadyoun and Oppenheimer (1939) throws much light upon the physiology of the filling and emptying of the appendix. It is a combined roentgenological and histopathological study, an ideal collaboration. In the investigations the appendix normally filled from the cæcum about six hours after a barium meal. This is stated to be by the pressure exerted by normal cæcal peristalsis. The emptying of the appendix is essentially due to appendicular peristalsis uninfluenced by extraneous conditions. Even severe constipation rarely causes delay. The appendix is always emptied of its barium before the cæcum. Kinks form no barrier to the entrance or evacuation of the barium, and free mobility of the appendix is not essential. It was found that when the appendix failed to empty it was always because it was in a diseased condition. They state that in appendicitis, whether acute or chronic, stasis in the appendix is the leading roentgen sign.

On the histopathological side they point out that not only is the muscle involved but the nerve plexuses also, and here we get the explanation of the "neuromuscular fault" promulgated by Prof. Shattock (1916, 1920).

An analysis of operative material reveals some interesting facts. In cases of acute appendicitis the lumen of the appendix is usually empty unless there is a stercolith, and often when a stercolith is present it is the solitary occupant. On the other hand, in cases of chronic appendicitis the lumen is often occupied by fæces and often in quantity and frequently in the distal part. These conclusions are the result of an analysis of a series of 136 consecutive cases of appendicectomy; 81 were cases of acute disease, 55 cases were considered to be chronic. In the acute cases, the lumen of the appendix was empty in 39 (48 per cent), a stercolith was present in 26 cases (32 per cent), and fæces present in 16 cases (20 per cent). In 55 cases of "chronic appendicitis" the lumen of the appendix was empty in 20 cases (36 per cent), whereas in 35 cases there were fæces present (64 per cent), roughly two-thirds of the whole number. Furthermore, considered in conjunction with Aschoff's hypothesis, 28 cases, i.e., roughly 50 per cent, had fæces in the *distal* part of the appendix.

Type	No. of Cases	Lumen contained Fæces	Lumen Empty	Stercolith Present
Chronic	55	35 (64 per cent)*	20 (36 per cent)	
Acute	81	16 (20 per cent)	39 (48 per cent)	26 (32 per cent)

* Of the chronic cases with fæces in the lumen 50 per cent had fæces in the distal part.

These figures, placed alongside the observations of Sadyoun and Oppenheimer, seem to me sufficiently convincing to justify a repudiation of Aschoff's secondary contention. In all the chronic cases records were kept of the condition of the appendix, and in the majority

there was definite disease. This again bears out Sadyoun and Oppenheimer's contention that stasis is due to disease. The striking difference between the figures in the acute and chronic cases calls for comment. It suggests either that previous to the acute attack the appendix was perfectly normal or that if stasis were present the appendix was emptied sometime earlier in the attack. If we accept the contention that only with disease does neuromuscular inco-ordination follow we must eliminate the cases with a stercolith as no longer normal. We must, however, go further, for there is no doubt that cases of acute appendicitis occur where, without a stercolith, there is a definite history of previous attacks, with manifest signs, such as the thickening of its wall with fibrosis, yet in such cases the lumen may be empty. Is it possible that in the presence of an acute attack with congestion of the parts an excessive stimulus is forthcoming? It is not easy to explain the position otherwise if the initial work of Sadyoun and Oppenheimer is correct, and it certainly impresses me as sound. We have to remember, however, that their investigation work was almost certainly not carried out in cases suffering from *acute* appendicitis. I venture the opinion that in the presence of the intense irritation of infection and congestion that such a forcible cleansing takes place and that it may well explain the colic (para-umbilical pain) which ushers in an acute attack. It also seems a reasonable explanation of the extreme severity of the pain which in many cases is associated with obstructive appendicitis, a valiant effort to clear the appendix of the menace.

We have no knowledge of appendical activity during an attack of acute appendicitis, least of all the work of the neuromuscular apparatus, and it is possible on the supposition set out above that occasionally a stercolith may be forced out of the lumen and unpleasant complications avoided. We have some evidence suggestive of this: in some acute cases there is much fluid in the appendix quite filling it and yet not under tension, suggesting that such a sequence has taken place. It may also explain the cases of true obstructive appendicitis where no stercolith or stricture is to be found, although here I think a spasmodic contraction of circular muscular fibres must be envisaged also.

Lansdown and Williamson describe a narrowing of the appendix as the determining factor in the formation of the stercolith. They write of "concretions formed behind more or less well-defined strictures". Aschoff sees a kink or bend shutting off the distal part of the appendix and by stagnation allowing concentration of the special flora. He attaches no special importance to the stercolith unless it is that, situated often in the distal part, it is a potent factor in shutting in the local special infection with which it also, he states, becomes infected. Aschoff again states that gangrene of the appendix, which may be considered a measure of the virulence and concentration of the infection, is always beyond the stercolith. Neither of these writers associates the stercolith with its hardness and the dangers of friction and pressure. Let us consider these points. Anyone who systematically examines appendices will agree that the stercolith is seldom if ever formed distal to a stricture. The stercolith can be either proximal or distal to a bend or kink and it is not uncommonly in the tip. In 23 consecutive cases with stercoliths, stony hard, the gangrene of the appendical wall was immediately underneath the stercolith in 17 cases and spreading beyond it in 6 cases. It was never proximal. This is only a small statistical record, but bears out an experience of years and a fact that I have often demonstrated to others.

Another point against Aschoff's contention that the stercolith blocks the lumen and so allows of concentration of the special flora and the more severe forms of the disease is *this* fact. Cases are not uncommonly found where fæcal masses in the appendix fill up the lumen at one part leaving a free open portion beyond. These cases, although the lumen is blocked and so should allow concentration of bacteria, do not lead to the graver manifestations of the disease. If we remember the stony hardness of the stercolith, the relative delicacy of the mucous membrane especially in the presence of congestion, the fact that the coincident swelling increases the pressure, combined with the hypothetical powerful contraction of the muscle which has been postulated, it is not difficult to realize the damage which may result. We should expect its greatest intensity in the region of the stercolith itself. Through thrombosis and toxæmia, it may well lead to peripheral gangrene in addition.

I venture to link up the statistics of the early part of this lecture (i.e., the stercolith as the factor in the severe types of the disease) with this explanation of the association. It is well also to remind ourselves as clinicians that there is no clinical evidence justifying the inference that a stercolith is present or absent, and so we can never foretell the potential gravity of the attack. There is no need to stress the relationship of obstructive appendicitis to the stercolith. Here the obstructive element is the factor, for a ligature would be as effective as a stercolith.

If we dismiss as untenable Aschoff's hypothesis of a special flora, we must yet agree that disease is usually in the *distal* part of the appendix in chronic disease as well as acute. It is in the chronic disease that the bulbous end is so often found, the visible expression of a fibroid degeneration with thickening of the wall and sometimes obliteration of the lumen. Also it is very noticeable how narrow and definite a line is often drawn between the affected and unaffected, or relatively unaffected, part of the appendix wall. Sometimes it is little more than a line. Cases are seen where the distal half may be a dark crimson whilst the proximal half is scarcely pink. This seems in itself sufficient evidence that the disease has started in the distal part well away from the cæcum and yet organisms of the cæcum, especially the

enterococci and B.C.C., are pronounced as infecting agents.

If we consider diseases such as tonsillitis and pneumonia we talk of some condition of "lowered resistance". As yet there is no known equivalent set of conditions whereby we can use the expression in reference to "lowered resistance" in appendicitis. Acute appendicitis usually attacks young people with no previous history of illness or malaise. If we could formulate some scientific justification for the expression we should have the final explanation that the organisms, normally living in the appendix and in the whole bowel, have become especially virulent, or that some change, local or constitutional, has rendered the individual vulnerable.

It may be that the mere proliferation in a narrow and enclosed stagnant space is sufficient.

Whilst clinically the acute case is usually of more interest, I think that in the study of aetiology the chronic cases with the earliest and simplest changes will be most helpful in the ultimate solution of the problem. This was the opinion of most of the workers quoted. It is interesting to note that Aschoff believed "that everyone goes through an attack of appendicitis (possibly two or three) just as they do attacks of tonsillitis. He found that 36 per cent of appendices removed where no history was forthcoming (being removed during laparotomies for other purposes), showed signs the counterpart of those found in cases of mild but definite cases of appendicitis. At one time I examined a number of appendices removed post mortem, and the impressions received supported Aschoff, but the numbers were too small, and the examinations too infrequent, to justify any final opinion.

To sum up: there is reason to believe that the disease is intrinsic, starting in the mucous membrane as an infective catarrh; that the causative organisms are those enumerated by Aschoff; but there is no reason to believe that the organisms are the creation by segregation of a special group, but rather that they are primarily derived from the cæcum and, possibly from stasis and proliferation, take on an infective character, whilst their fellows in the cæcum, fewer in proportion and not so static, remain inactive. Any other reason, cellular or biochemical, for their taking on this infective character we do not know.

In conclusion I have put before you a general survey, collected a few facts, and ventured on some hypotheses of my own. It has become evident in the course of these primarily clinical investigations that a broader, wider, and more comprehensive inquiry should be the approach to such problems. In the present day this should be possible and a co-ordinated investigation including clinical, pathological, roentgenological, and possibly biochemical experts is the ideal. Each would have to understand the other man's point of view, help to separate fact from fancy and proof from wishful thinking. I am the more cognizant of the value of co-ordination of groups from my appreciation of the help I have received from the scientific department of the Medical School of Cambridge University, and especially from Professor Dean, of the Department of Pathology, and his colleague, Dr. Williamson.

REFERENCES

ASCHOFF (1920), *Der appendicitis Anfall.* Berlin.
— (1931) *Ziegler's Beiträge*, **87**, 481.
BEHAN (1921), *Amer. J. med. Sci.*, **162**, 705.
BOWEN (1937), *Appendicitis: A Clinical Study.* London: Cambridge University Press.
DUDGEON and MITCHENER (1923–24), *Brit. J. Surg.*, **11**, 676.
EASTWOOD (1923), *J. Path. Bact.*, **26**, 69.
FISCHER (1921), *Dtsch. med. Wschr.*, **47**, 17.
HARRIS, COX, and BLACKLOCK (1930), *Surg. Gynec. Obstet*, **1**, 572.
KOSTER and WEINTROB (1928), *Arch. Surg.*, **17**, 677.
LANSDOWN and WILLIAMSON (1914–15), *Brit. J. Surg*, **2**, 306.
MACLEAN (1910), *Mitt. Grenzgeb. Med. Chir.*, **21**, 36.
REID (1914), *Proc. R. Soc. med.*, **7**, Pt. 2 (Obstet. and Gynec. Sect.), 158.
ROSENOW (1915), *J. infect. Dis.*, **16**, 240.
SADYOUN and OPPENHEIMER (1939), *Amer. J. Roentgenol.*, **41**, 188.
SHATTOCK (1916), *Proc. R. Soc. Med.*, **9**, Pt. 3 (Sect. Path.), 23.
— (1920), *Ibid.*, **13**, Pt. 3 (Sect. Path.), 105.
WALLER and COLE (1915), *Surg. Gynec. Obstet.*, **21**, 750.

THE METHODS AND RESULTS OF TREATMENT IN CASES OF PARALYSIS OF THE BLADDER FOLLOWING SPINAL INJURY

BY E. W. RICHES

SURGEON TO THE MIDDLESEX HOSPITAL

INTRODUCTION

THERE are but few of the special problems of war surgery which can be studied at first-hand in times of peace, but paralysis of the bladder following spinal injuries is one of them. There are many such cases even in peace time, and war brings them in larger numbers; their treatment then must often of necessity be carried out under conditions of difficulty; the more uniform it is, and the more easily it can be carried out in surroundings which may fall far short of surgical ideals, the better will be the results. After the last war Thomson-Walker (1937) estimated the total death-rate from urinary sepsis in spinal injuries as 80 per cent, and, although during the intervening

years of peace there have been advances in the treatment of the paralysed bladder, the incidence of urinary sepsis is still high and its effects are just as serious.

This account is based on a study of the end-results and methods of treatment in 35 cases admitted to four special centres in England during the present war, and I am greatly indebted to the Medical Officers of these centres for all they have shown me and taught me. I should also like to record my thanks to the Nerve Injuries Committee of the Medical Research Council for making this study possible.

THE MECHANISM OF MICTURITION

Only a brief summary can be given here of the accepted views on the means whereby micturition normally takes place.

The bladder and its sphincters derive their nerves from sympathetic, parasympathetic, and somatic sources, and of these only the parasympathetics are necessary for normal micturition. They arise from the second and third, and possibly the fourth, sacral segments and are the motor nerves to the detrusor muscle. There is normally a reciprocal relationship between the state of the detrusor and the so-call internal sphincter. The completely denervated bladder can still contract automatically but feebly.

The act of micturition is brought about by contractions of the detrusor which are initiated by distension and are accompanied by reciprocal relaxation of the internal sphincter. They are inhibited normally up to a point of tolerance, by impulses from the brain which become conscious as the content of the bladder increases.

THE CHANGES IN MICTURITION FOLLOWING SPINAL INJURIES

There are certain well-defined stages through which the bladder passes after spinal lesions which are in essential respects similar for all injuries causing paraplegia. These stages, in physiologically complete lesions are: (1) Complete retention; (2) Retention with overflow; (3) Periodic reflex micturition. In partial lesions a state of voluntary micturition, clinically indistinguishable from the normal, may follow directly from the first or second stages.

First Stage: Complete Retention.—Immediately after the injury there is a total suppression of all the functions of the isolated part of the spinal cord. This is the condition of spinal shock. The detrusor muscle of the bladder becomes flaccid whilst the internal sphincter remains closed in reciprocal relationship and the bladder gradually becomes distended. The external sphincter, like the anal sphincter, remains flaccid. The duration of the 'period of retention' is variable; it may last from one day to eighteen months and it does not give any reliable information about the degree of nerve injury. Even when the retention stage has passed it may return after any untoward disturbance such as an operation or the development of renal calculi. The inert distended bladder may fall back into the pelvis, but is usually recognizable by palpation and percussion; pain is sometimes present, as in incomplete lesions, but it may be absent even when the sympathetic pathway is intact.

Second Stage: Retention with Overflow.—If no steps are taken to remove it, urine will begin to dribble away from the distended bladder usually after twenty-four to thirty-six hours. The condition now resembles the late state of prostatic obstruction save that in the paralysed bladder of spinal injury there has been no long period of partial obstruction leading to gross renal damage, and the danger of renal failure in the spinal case is minimal in the absence of infection. Nevertheless, few cases are allowed to reach this stage of passive incontinence, and in this series there were only two.

Third Stage: Periodic Reflex Micturition.—At a varying interval after the injury the detrusor muscle begins to regain tone and recovers some degree of contractility in response to an increase of stretch. This is a gradual process, and so there is a transition period before the full development of reflex micturition. The first contractions of the muscle are feeble, but are accompanied by slight reciprocal relaxation of the internal sphincter. The bladder gradually becomes less distended and both its total capacity and the amount of residual urine diminish.

The period before the full development of periodic reflex micturition depends upon the general condition of the patient, the level of the lesion, its severity, and upon the presence of urinary infection. The level of the lesion has a bearing on the delay in automaticity. Thus in 5 cases of cord lesion which attained a periodic reflex the average time before its full development was twelve weeks; the shortest was four weeks; and the longest twenty weeks. In 9 cases of cauda equina lesion the average was twenty-six weeks, the shortest being six weeks and the longest sixty-eight weeks. The longer time taken in the lower injuries in this series is in agreement with the conclusions of Holmes (1933). In either case the stage of full periodic micturition is characterized by intermittent and spontaneous contractions of the bladder with the voiding of the whole or, more usually, part of its contents. The act is involuntary and cannot be prevented or interrupted; it can sometimes be started by abdominal straining, but only if there is an adequate amount of urine in the bladder; it may also be started by movement, but there is no example in this series of the initiation of the act by an educated reflex. Distension of the bladder can be appreciated by some patients and this may give warning of an impending contraction. The sensation of urine passing through the urethra is less frequently retained, but there is sometimes a complaint of pain in the penis either before or

after the act. The time interval between the acts varies from about fifteen minutes in a badly infected case to four hours where there is no infection, and the amount passed from about 2 oz. to 10 oz.

Variations in the Periodic Reflex at Different Levels.—Automatic emptying of the bladder may follow a lesion at any level of the spinal cord or cauda equina, but the phenomenon is best developed in complete supra-lumbar lesions of the cord. Here there are reflexly active spinal segments present below the lesion, although it is believed that the mechanism of emptying is still carried out by the vesical plexus (Denny-Brown and Robertson, 1933).

In *complete supra-lumbar lesions* the act of micturition is truly automatic. Vesical distension may be appreciated by painful sensations in the lower abdomen or penis, and there is in this way sometimes a short warning period which may increase with the passage of time to reach as long as two minutes. The stream is usually powerful and the inability to interrupt or delay it was shown by the remark of one patient that "it came in floods." There may, however, be some intermission, so that the urine comes in rhythmic jets. There is usually no sensation of urine passing through the urethra and the act stops suddenly. The bladder is not always completely emptied, but the amount of residual urine rarely exceeds 2 oz. The periodicity of the act varies with the stage of development and the degree of infection. The whole reflex may be abolished and the patient reduced to dribbling incontinence by severe local or ascending infection, or by general toxæmia or intercurrent disease. Micturition of this type is most unsatisfactory; the patient is likely to be permanently bedridden and he must keep a urinal in place at all times with a consequent increase of urinary infection and a constant liability to a wet bed. From the bladder point of view the most satisfactory case of the six complete supra-lumbar lesions in this series was the one who had an early suprapubic cystotomy; his bladder was comfortable, whilst in most of the others it was a nuisance.

In *cauda equina lesions* the periodic reflex differs from that of the cord lesions in that its average time of development is more than double and in the nature of the act. Distension of the bladder is generally perceptible to the patient and gives a warning of impending micturition which is as long as fifteen minutes in a good case with little infection, but is generally less; it tends to increase with the passage of time. The act is then started by straining, and contraction of the the abdominal muscles. The stream is good whilst straining continues but falls off as the abdomen is relaxed; the bladder is not always completely emptied. After the act no further micturition takes place for a period which varies with the stage of development and the degree of infection from an hour to four or five hours, but if over-distension is allowed to occur, a purely involuntary evacuation takes place. Most of the patients, therefore, make their efforts at regular intervals, and many are able to go through the night dry.

The striking feature about the act of urination in these cases is the use of the abdominal muscles to assist expulsion. Denny-Brown and Robertson (1933) have shown that after complete cauda equina lesions there are spontaneous waves of vesical pressure of small amplitude and insufficient to empty the bladder, but that pressure applied to the bladder through the abdominal wall produces secondary contractions of the detrusor with reciprocal relaxation of the internal sphincter allowing micturition to take place. Such a partly controllable automatic micturition is quite compatible with a reasonable mode of life for a man of average intelligence.

FIG. 121.—Cystogram; cauda equina lesion. An irregular hypertonic bladder with a funnel neck and reflux up a dilated left ureter.

Watkins (1936) drew attention to the relaxation of the bladder neck and posterior urethra seen in some of these cases and shown on a cystogram and on cystoscopy as a funnel-neck deformity (*Fig.* 121). This dilatation is probably due to passive stretching associated with paralysis of the detrusor. As the external sphincter is paralysed in complete cauda equina lesions the resistance to the outflow of urine in these cases must be explained on some other grounds than those of sphincteric control. Watkins suggested that it was due to the elasticity of the tissues in the region of the triangular ligament. It is of interest to note that all his patients with cauda equina lesions were males, in whom there is more mechanical resistance from the length and curve of the urethra; in this series there were six cauda equina lesions in females, in whom the degree of mechanical obstruction is much less. Three developed automatic micturition, and in

them any disturbance was likely to be followed by incontinence; such disturbances were exemplified by the operation of laminectomy, the formation of renal calculi, the giving of a strong aperient, an attack of phlebitis, and the Christmas festivities. Amongst the men the tendency after similar disturbances was towards retention. These facts support the view that the difficulty in micturition after cauda equina lesions is due not only to the feeble contractions of the bladder but also to mechanical resistance around the posterior and bulbous urethra; the determining factor in deciding whether a suprapubic cystotomy is better than automatic micturition may be the sex of the patient.

Voluntary Micturition.—Of 24 cases with incomplete nerve lesions 9 recovered voluntary micturition after intervals varying from one day to fifteen months. In all these cases the nerve injury was evidently not severe. The act of micturition was not immediately normal after the period of retention; there was at first pain and frequency, straining, and delay in starting, and 3 of them needed parasympathetic stimulant drugs at different times to enable them to void. There were 4 lesions of the cord and 5 of the cauda equina. The presence of a suprapubic tube for nine months in one of the former and for thirteen months in one of the latter did not prevent the return of an act which was ultimately clinically indistinguishable from the normal save for the presence of infection and up to 2 oz. of residual urine.

A summary of the final state of the act of micturition in this series at times up to two years from the onset shows the following results :—

	Total	*Periodic Reflex*	*Voluntary Micturition*	*Permanent Drainage*
Spinal cord	16*	5	4	5†
Cauda equina	19	9	5	5
Total	35	14	9	10

* 1 case incomplete, 1 incontinent.
† 2 suprapubic, 3 urethral catheter.

Neglecting the incomplete case and the incontinent case, of 33 cases of bladder paralysis following spinal lesions about 30 per cent were left with permanent drainage by suprapubic cystotomy or urethral catheter and 70 per cent passed urine by the normal channel either voluntarily or by periodic reflex.

Of the methods of emptying the bladder finally attained only 3 may be considered to be compatible with the optimum mode of life the patient may be able to lead subsequently; they are: voluntary micturition; the periodic reflex of a cauda equina lesion; permanent suprapubic cystotomy.

TREATMENT

We are here concerned with only one aspect of the care of a patient with a serious injury, but it is axiomatic that the treatment of the bladder must in no way interfere with the other measures necessary to promote his recovery. These measures demand an exceptionally high standard of nursing care and the closest co-operation between the neurologist, orthopædic surgeon, urologist, physician, and surgeon. One of the first principles in management is, therefore, the concentration of the cases in centres where this collaboration is possible. Even in this country there have been difficulties in getting patients transferred to the special centres and in this series the average delay was six weeks.

The aim of the urologist must be to assist in the establishment of the best type of micturition possible in each particular case. The methods of attaining this result are many and varied, the obstacles few but formidable, and it will be an obvious advantage if the treatment of the bladder, especially in the initial stages, can be stereotyped, for the problem is here the same in all cases, that of retention of urine. Moreover, the primary treatment will be the responsibility of the first medical man who sees the patient, and if positive rules and prohibitions can be laid down for his guidance some of the later disasters will be avoided. Treatment in the early stages may have to be carried out under unfavourable conditions, and may demand different methods from those which can be applied later on when the patient is in a well-equipped hospital. The methods are :—

1. Non-interference.
2. Manual expression.
3. Catheterization.
   a. Intermittent.
   b. Continuous.
   c. Continuous, with tidal drainage.
4. Suprapubic drainage.
   a. Cystotomy.
   b. Aspiration.
   c. Catheterization.
5. Adjuvant treatment.

The main obstacles to the achievement of a good result are infection, urinary leakage, and over-distension of the bladder.

Infection is the most serious of these obstacles; its local manifestations will delay recovery, but its main importance lies in the fact that ascending infection develops rapidly from an infected bladder which cannot empty freely. Pyelitis and pyelonephritis follow and the latter is either fatal in its acute stage or leads to a degree of chronic urinary sepsis for which no cure is possible. Stone formation is largely due to infection and in these cases prolonged recumbency gives an added impetus to the growth of calculi. It was pointed out by Vellacott and Webb-Johnson (1919) that the infection was produced by catheterization, for out of 10 cases not catheterized before admission to hospital only 1 had a mild infection due to *B. coli*, and there were no deaths, whilst of 40 who had been catheterized, 31, or 77·5 per cent, were already infected, and of these 7 died from urinary sepsis, a mortality of 17·5 per cent. In the present series of 35 cases 27 were clinically

infected, an incidence of 77 per cent; there were 10 deaths, a mortality-rate of 28·5 per cent, and 5 were associated with ascending infection, a mortality of 14·3 per cent up to two years. Many

FIG. 122.—Cystogram; atonic bladder holding five pints, with no ureteric reflux. Prolonged overdistension for five years.

FIG. 123.—Cystogram; same case as *Fig.* 122, two years after prostatectomy. Capacity two pints.

of those still living suffer from chronic urinary sepsis and some will yet die from it.

Ascending Infection and Ureteric Reflux: It has been suggested that lavage or manual expression may force fluid up a dilated ureter. In some of these cases the ureter is dilated and shows a reflux on filling the bladder, but it appears commoner in a hypertonic and contracted bladder than in the atonic distended viscus. *Fig.* 121 shows such a reflux in a neglected cauda equina lesion, whilst by contrast the enormously distended atonic bladder shown in *Fig.* 122 had no ureteric reflux. Bell (1812) had observed and depicted that in a distended bladder the intramural part of the ureter was flattened and had a more competent valvular action than when the bladder was contracted and the ureter ran less obliquely. This is in accord with the cases quoted above, and is opposed to the idea of a reflux being due to distension. It therefore seems unlikely that a retrograde urinary stream is a common mechanism of early ascending infection. The experimental work of Walker (1913) and of Winsbury-White (1933) has shown conclusively that it is the periureteral lymphatics which form the route of ascending infection from the lower urinary tract in ordinary cases of ascending urinary infection, and there is no reason to suppose that it differs after spinal injuries.

Urinary Leakage is a contributory cause of the early appearance of pressure sores in anæsthetic areas. It occurs in the stage of overflow incontinence and provides the most cogent argument against the method of non-interference. It is seen also after a low suprapubic cystotomy, and if this is combined with a plaster jacket the toxæmia produced by the sores alone may be fatal. In one such case there were pressure sores extending from the buttocks to the waist and urinary dermatitis up to the nape of the neck.

Overdistension of the bladder is only dangerous if it is prolonged or if infection is also present. In the latter event mucosal ulceration or sloughing are possible sequelæ, so that if the patient has been catheterized subsequent overdistension should not be permitted. A second result attributed to overdistension is such stretching of the detrusor muscle that it never recovers any contractile power; permanent detrusor paralysis is only likely if overdistension is prolonged. Long continued distension even in the non-paralysed bladder may produce a degree of fibrosis and atony which is permanent. In a man of 60 with a five-year history of prostatic obstruction the bladder held five pints (*Fig.* 122); two years after prostatectomy it still held two pints (*Fig.* 123), and there was nearly half a pint of residual urine. In this case the distension resulted from long-standing chronic obstruction. Rupture of the bladder has also been suggested, but I can find no record of rupture from overdistension alone.

METHODS OF TREATMENT USED, AND THEIR RESULTS

In this series nearly every patient was treated by more than one method; the frequency with which each method was used gives an indication

both of the trend of practice and of the diversity of opinion. It was as follows :—

Intermittent catheterization	26
Tidal drainage with urethral catheter	15
Suprapubic cystotomy	13
Continuous catheterization (indwelling catheter)	7
Manual expression	2
Non-interference (overflow incontinence)	2

In addition, drugs of the parasympathetic stimulant type described later as adjuvant treatment were used in one mild case as the exclusive method of treatment. The available methods must now be considered individually.

1. Non-interference.—To a surgeon accustomed to dealing with the commoner causes of acute retention, it may seem fundamentally unsound to leave the condition unrelieved, and this is the probable explanation of the paucity of cases so treated. The method of waiting for overflow incontinence to appear was used in only 2 cases of this series, both with incomplete lesions of the cauda equina. In one, a girl of 19, retention persisted for three days, and she was, in fact, catheterized once, fortunately, without becoming infected. Thereafter she had overflow incontinence for seven weeks before periodic reflex micturition was established. She developed pressure sores and had to be turned on her face in an anterior plaster shell, and it was not possible to reduce her fracture-dislocation. Nevertheless, after fifteen months she had a satisfactory bladder function and showed no signs of urinary infection throughout her illness. In the other, a man of 37, overflow incontinence was allowed for a limited number of days ; someone then succumbed to the temptation to catheterize him, and his urine became infected ; after two months he had periodic reflex micturition. The absolute contra-indications to the policy of non-intervention are existing cystitis, toxæmia from general causes, and severe pain. The main disadvantage of overflow incontinence is the difficulty of preventing a wet back, especially in women. It is, therefore, not an ideal method, but it is safer than catheterization.

2. Manual Expression.—This method aims at stimulation of detrusor activity by pressure applied through the abdominal wall. It has already been pointed out that in the stage of spinal shock the bladder becomes flaccid, and there is in consequence reciprocal closure of the internal sphincter ; both these two interdependent conditions make manual expression difficult, and, in fact, Holmes (1933) states that it may be impossible in the first one or two weeks. The method is not so easy as its name would suggest, at least in the early stages when a non-instrumental method would be of most value. It was used in 2 cases in this series, both of complete lesions of the lumbar segments. In one it was sometimes successful in the first days in enabling the bladder to expel up to 6 oz. of urine, but intermittent catheterization was also necessary ; a periodic reflex was acquired eventually. In the other it was used after an interval of a week, during which intermittent catheterization had been employed. At this time the bladder could be emptied completely by expression, but after two days the method had to be abandoned as the patient was put into a plaster jacket. Vellacott and Webb-Johnson reported 1 case of bladder rupture, and there had been at least 1 similar case during the present war. It would, therefore, seem that the method, although of use in a limited number of cases, is neither sufficiently certain nor sufficiently safe to be recommended for routine use ; it cannot be used in conjunction with a plaster jacket, and it should certainly not be attempted if the bladder is already infected. It is contrary to E.M.S. instructions (1940).

3. Catheterization.—

a. Intermittent Catheterization.—This remains the most popular method of treatment, at least in the initial stages ; it was used in 74 per cent of this series which includes both air-raid casualties on the home front and soldiers from overseas. Whilst infection may be produced by a single act of catheterization, its ultimate persistence and severity depend more on the length of time over which the procedure is continued. The limit of time over which it can be carried out without producing permanent serious infection appears to be two days. Of the 26 cases treated by intermittent catheterization the process was continued for more than two days in 21 ; every one of these patients had a more or less serious degree of infection at the time of death or after periods of up to two years. Of the 5 cases in which intermittent catheterization was not continued for more than two days, none had clinical or post-mortem evidence of infection at the end of the same period ; in other words, intermittent catheterization for more than two days produced permanent infection in 100 per cent of cases, whilst if used for not more than two days the incidence of ' permanent ' infection was nil.

The technique of catheterization is an exacting one and requires surgical surroundings which may not be available for war casualties within the first twenty-four hours. For such cases, too, there is no continuity of treatment by one surgeon, and with a sudden influx of a large number of casualties the urgency of other problems may detract from the perfection of technique required. The patient is shocked, his bladder is deprived of its nerve-supply and is in a receptive state for the multiplication of a few organisms which might cause no harm to a healthy individual. In practice the method leads to infection and should, therefore, be forbidden, despite the E.M.S. instruction (1940) that " the bladder should be emptied by catheter as soon as possible after the injury ".

b. Continuous Catheterization (Indwelling Catheter).—In theory an indwelling catheter providing continuous drainage is better than intermittent catheterization ; in practice it is

worse and is followed by a more severe degree of infection than any other method. It was used in 7 cases in this series for periods of from one day to ten weeks and all seven developed a gross urinary infection and showed amongst them the following complications: severe cystitis, alkaline incrustation with incontinence, epididymo-orchitis, blood-nitrogen retention, pyelonephritis, and recurrent renal stone formation. An indwelling catheter may drain the bladder but does not drain the urethra, and it will always cause urethritis. It is now twenty-five years since Thomson-Walker (1917) condemned the indwelling catheter as unsuitable for the continued treatment of retention in paraplegia, yet it has been used again with similar bad results. It must also be recorded that it was chosen by Kidd (1919) as the best method of treatment, largely because of its time-saving properties. His technique was faultless.

c. Continuous Catheterization with Automatic Tidal Drainage.—The popularity of this method is shown by the fact that it was used at some stage in nearly half the cases in this series, and it therefore demands full consideration. The idea of continuous irrigation of the bladder, followed automatically by emptying at a pre-determined capacity, was first put into practice at Guy's Hospital by Laver in 1917, and whilst Munro (1935) in America has developed the idea and put it to more extensive use it is right that full credit should be given to the originator, for the principles he employed have not been altered in all the many modifications which have been described since. These principles are that water finds its own level, and that of the siphon. In practice fluid drips from a container at a slow rate; it can enter the bladder by way of a catheter and can also enter a siphon tube of adjustable height. When the fluid reaches the top of this tube siphonage starts and the bladder is emptied; a vent lets in air to break the siphon and the process is repeated. Variations in pattern mainly concern the presence or absence of a reservoir interposed in the system, but in general it can be said that a reservoir is undesirable as it may allow stagnant urine to be returned to the bladder in each cycle. It is preferable that a manometric tube should be incorporated in the apparatus; it can act also as the air vent. An initial cystometrogram indicates the type of bladder being treated and the height at which the siphon should be set for any desired capacity of the bladder. This height should not exceed 5 cm. for an atonic bladder, whilst a hypertonic bladder may require 30 cm.

Munro (1936) has used his apparatus in the treatment of the paralysed bladder and claims that it has no contra-indications except for complications due to misuse. The incidence of urinary sepsis was reduced from 73 per cent in 33 cases without tidal drainage to 15 per cent in 26 cases with it. This is a striking achievement and one which makes the method worthy of proper trial. Unfortunately most of the cases in which it has been used in this series were already infected by intermittent catheterization; in some of them the vesical infection was reduced, but where renal infection was present tidal drainage failed to influence it. Of the 15 patients in whom the method was used at some stage only

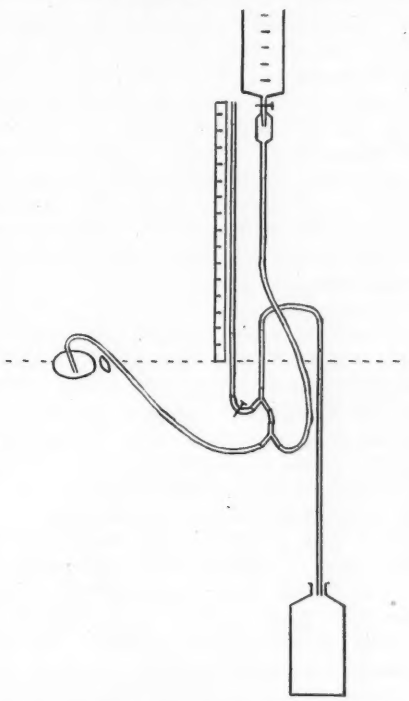


FIG. 124.—The 'double Y' tidal irrigator and cystometer. Both Y tubes are inverted and entering fluid passes upwards; any air with it will pass out from the stem of the Y and none enters the bladder. For cystometry the end of the siphon tube is hooked up to the container, but left open to the air.

1 had it as the initial form of treatment, and in him it had to be stopped after one day owing to recrudescence of an old urethritis. Only 2 of the 15 were reasonably free from infection ultimately; one developed a periodic reflex after eleven weeks of tidal drainage but died two weeks later with no post-mortem evidence of gross infection, and the other, a woman who had been catheterized for only two days and who remained uninfected after nine days of tidal drainage, regained voluntary micturition. The time required for the development of a periodic reflex in cases treated by tidal drainage was slightly less than the average for the series. The longest time it was used was seventeen months, and the woman then had a dilated and incompetent urethra which had to be plicated to prevent incontinence. The disadvantage of the method is that it entails the use of an indwelling urethral catheter with many of its attendant drawbacks, and most of its faults can be traced to the catheter. If used at all it should only be done in a special centre or a hospital where the medical and nursing staff are familiar with it. Of the machines in use

the Bellis (1940) or its modification by Stewart (1942) has proved satisfactory, as has the 'double Y', here illustrated (*Fig.* 124), which tends to clear itself of air if any should enter. The Lawrie and Nathan type (1939) is the simplest, but is prone to air-locks and has no cystometer.

4.—Suprapubic Drainage.—

a. Cystotomy.—Drainage of the bladder has long been the accepted method of treatment of cystitis accompanied by obstruction in the lower urinary tract and infection has been regarded as the chief indication for suprapubic cystotomy in bladder paralysis; in most cases the operation has been delayed until infection is already present. Cystotomy will prevent ascending infection if done sufficiently early, but if such spread has already occurred it will have little influence on it.

In this series suprapubic cystotomy was performed in 13, or nearly a third of the cases. Its time of performance varied from one day to seventeen months after the injury. In only 4 cases was it done sufficiently early to prevent serious infection, and in none of these was it delayed beyond the fourth day. Of the remaining 9 cases 7 had a severe degree of sepsis, from which 3 of them ultimately died. Of the 7 badly infected cases 4 developed renal calculi.

During and after the last war the subject aroused much controversy. Thomson-Walker (1917) advocated early cystotomy before any catheter had been passed, and described the method which he recommended. The method was not found satisfactory, as many of the openings leaked around the tube and the patients were seldom dry; contraction of the bladder also occurred. Both these disadvantages are due to faulty technique; the fault lies in making the fistula too low. Whilst Thomson-Walker performed a great service in demanding early suprapubic cystotomy, the operation as he described it could only result in a low fistula, for his incision extended vertically upwards for 1¼ in. from the symphysis pubis; he admitted that the wound leaked in the first week or so (1917). In 1937 he drew attention to the method of cystotomy introduced by Mothersill and Morson in 1921; these authors described an incision of about ¾ in. in length just above the pubes. The sheath of the rectus was then cut and its fibres separated with the finger so that a trocar and cannula, the latter fitting a No. 28 de Pezzer tube, could be plunged through the bladder wall. Thomson-Walker added the words "directly backwards". Whilst the trocar and cannula method should give an immediate watertight junction, the final results of such a low cystotomy are unfortunately only too well known. The fistula leads straight forwards out of a contracted bladder; it frequently leaks, it makes a suprapubic urinal difficult to adjust because it is just above the bone, and it takes a longer time to close than an oblique track should such a course become desirable later on.

Just as the idea of the necessity for immediate relief of the urinary retention in these cases is a relic of older ideas derived from obstructive cases, so the persistence of low suprapubic cystotomy appears to be descended from the fear of wounding the peritoneum; the first recorded case of suprapubic lithotomy was by Pierre Franco in 1556, but it was not until 1723 that John Douglas, lithotomist to the infirmary at Westminster, was able to present a sufficient number of cases to show that the operation was a safe one. Suprapubic cystotomy through a high incision is also a safe operation, although it is not quite so easy as the low operation.

The best incision is a transverse one, 1½ in. in length, and placed at the mid point between the umbilicus and the symphysis. Some surgeons may prefer a vertical incision, but it should occupy only the middle two-fourths of the line between the umbilicus and the symphysis. The exposed bladder is held up by a pair of fine metal hooks, and the trocar and cannula passed in a downward and backward direction. A No. 28 (F) Malecot catheter is introduced through the cannula.

This operation produces a leak-proof fistula; the track becomes lined by granulation tissue and the catheter can be safely changed after ten to fourteen days, The bladder becomes adherent to the abdominal wall at the site of the fistula and cannot undergo the same degree of contraction as it does with a low fistula. The track remains oblique and will close readily when desired.

The disadvantages of a low fistula were seen in 6 cases out of 13, leakage being more troublesome than contraction, for after the fistula is closed the bladder will sometimes dilate again. Of the 13 cases 7 were left with a permanent fistula, 3 developed a periodic reflex, 2 recovered voluntary micturition, and 1 is incomplete. The average period of drainage in the 5 cases which regained micturition by the normal channel was twenty-five weeks, the longest being thirteen months; this refutes the prevalent idea that suprapubic cystotomy prevents such return of function. Gowlland (1934) gave an account of the later life of some of the spinal patients after the last war; there were some who preferred a suprapubic tube to the risks of a periodic reflex act.

It may be concluded that suprapubic cystotomy is a safe and effective treatment for the paralysed bladder and that if done early it will prevent serious infection. It does not prevent the development of periodic reflex micturition nor the return of voluntary micturition. It is more satisfactory in both early and late stages if the opening is made high. In most cases the fistula is made too late, in many too low, and in some too large.

b. Suprapubic Aspiration.—The facts so far presented have gone to show that the ultimate fate of the patient may well depend on the initial treatment applied for his urinary retention. The safest policy yet considered in the stage when

surgical facilities are absent is that of non-intervention, but in cases where the bladder *must* be emptied, if such exist, it can be done by aspiration through a serum needle. The only real danger of the method lies in its repeated use, for extravasation is more likely to occur if the bladder is allowed to distend again after aspiration. It is suggested as a means of relieving retention which is causing severe pain, and when surgical surroundings are poor but are likely to be better within twelve hours.

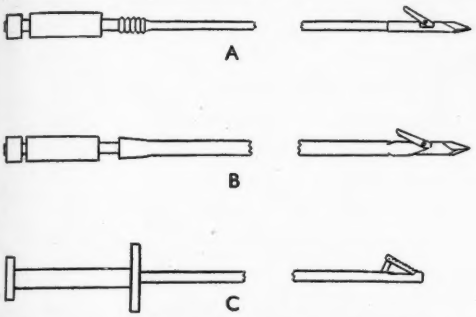


FIG. 125.—A, Suprapubic catheter introducer. B, The introducer with the catheter stretched ready for insertion. C, The advancer.

Aspiration is unlikely to be required within the first twenty-four hours after the injury; it is not an ideal method because of the danger of extravasation, but it is safer than catheterization. It should not be used if the urine is already likely to be infected.

c. Suprapubic Catheterization.—In an attempt to discover the ideal method of treatment for the stage of retention it has been shown that suprapubic cystotomy whilst safe is not always possible owing to adverse conditions, and sometimes has unfortunate sequelæ. Suprapubic aspiration is easy even under difficult conditions, but it should only be done if the patient can reach proper surgical surroundings within a limited time, preferably in twelve to twenty-four hours. In modern warfare no such guarantee can be given. The solution of the problem appears to lie in the introduction of a small suprapubic catheter, and an instrument has now been produced by which a No. 16 (French) Malecot type rubber catheter with an open end can be introduced into the distended bladder without dissection and left there, the catheter being made to act as the cannula. This has now been used in over 20 surgical cases and has proved simple and effective as a means of bladder drainage. I have also used it in 4 spinal cases, and whilst it is too soon to assess the final results, it has been most successful in the early stages (Riches, 1943).

If an anæsthetic is necessary local infiltration is adequate. The needle should take the track to be followed by the introducer and should be pushed into and through the anterior bladder wall whilst the injection is being made.

The introducer (*Fig.* 125) is a steel trocar with a small knife blade at its lower end which can be opened and closed by a screw at the upper end. The back of the blade grips the catheter which is stretched on the trocar to obliterate the self-retaining wings. The patient is tilted head down as in suprapubic cystotomy or aspiration.

The catheter is marked at distances of 2, 3, 4, and 5 in. from its tip. The instrument is introduced at the highest point of bladder dullness or at the mid-point between the umbilicus and symphysis, whichever is the lower, and its direction is downwards and backwards so that it makes an angle of 45° with the skin of the abdominal wall. The trocar passes readily through the tissues and the knife blade enlarges the opening just enough to let the catheter slide in easily. For an average adult it is passed to the 2-in. mark. The blade is then opened slightly, the catheter head is thereby released and recoils clear of it. The blade is then closed and the introducer withdrawn, leaving the catheter in position. The catheter is gripped firmly by the abdominal wall and another instrument is necessary to push it farther into the bladder. This 'advancer' has a spring-controlled expansion at its lower end; it is half an inch shorter than the catheter. It is inserted into the catheter and expanded to grip the wall, and the catheter is then pushed to any desired depth, usually about 5 in. into the bladder. The soft rubber head of the catheter leads the way so that there is no danger of injuring the bladder wall. It is necessary to advance the catheter far enough in to prevent the bladder from slipping over the self-retaining wings should it be emptied quickly. A rubber shield with a fully curved tube is threaded over the catheter and fixed by strapping to the skin to prevent accidental withdrawal. In practice the bladder is always emptied slowly for the first two days; this ensures its adherence to the site of the fistula and prevents the complication of contracted bladder at a later stage. After two days the catheter is connected to a tidal drainage apparatus which is retained as long as necessary. The catheter fits the sinus closely and gives a completely water-tight joint. After ten days it can be changed for a plain open-ended rubber catheter of the same size which slips in easily without an introducer and is held by the shield.

As a safeguard against injury to the peritoneum the operation is only done when the bladder is distended and with the patient in the Trendelenburg or a comparable position.

The method has many advantages; it is simple and rapid and permits the introduction of a small drainage tube which will overcome the difficulties of the initial stage of retention and will usually suffice for the continued treatment of the bladder until functional recovery occurs, when the small opening will close quickly. The cases already treated have shown that provided the tidal irrigation is kept in clean working order the method is both efficient and time saving. There is no leakage at any time, infection is controlled, the advantages of tidal drainage are

obtained without the disadvantages of a urethral catheter, and there is no interference with the treatment of the spine by any accepted method.

Figs. 126, 127 are photographs of a patient on the fourth day after suprapubic catheterization.

FIG. 126.—A patient on the fourth day after suprapubic catheterization. The opening is high and watertight.

FIG. 127.—The suprapubic catheter retained by a shield.

5. Adjuvant Measures.—These are: (*a*) Parasympathetico-mimetic drugs; (*b*) Urinary antiseptics and acidifiers; (*c*) Lavage; (*d*) Bladder drill; (*e*) Ancillary operations; (*f*) Treatment of calculi.

a. Drugs of the acetylcholine type have no effect during the stage of spinal shock, but can be employed with some effect when bladder contractility has recovered, or to re-establish the act which had been lost after operation or some other disturbance.

b. Urinary Antiseptics and Acidifiers.—The sulphonamides and mandelic acid have each proved of service when given in short intensive courses, but hexamine has remained the standard medicament for administration over longer periods. The acidity of the urine appears to be of more importance than any antiseptic effect of a drug; an alkaline urine encourages the formation of phosphatic stones. As an acidifier ammonium benzoate causes less gastro-intestinal disturbance than ammonium chloride, and either is more effective than acid sodium phosphate. No urinary antiseptic can compete with an indwelling urethral catheter.

c. Lavage.—Whether the bladder is drained via the urethra or a suprapubic tube the track becomes infected, and some infection reaches the bladder itself. It is customary to deal with this by lavage, and doubtless the mechanical effect of copious washing helps to keep the mucosa clean. The advantages of automatic tidal irrigation through a suprapubic catheter are considerable in that the volume of fluid entering can be controlled and the saving of time is of great practical importance.

d. Bladder Drill.—Munro (1936) has described a method of re-education of the bladder in patients who are recovering voluntary micturition, and who have been treated by tidal drainage with an indwelling urethral catheter. Re-education has also been claimed as one of the advantages of tidal drainage itself, the siphon being set at a progressively higher level as improvement continues.

e. Ancillary Operations.—Transurethral resection of the internal sphincter (Nesbit and Gordon, 1941) and resection of the presacral nerve (Learmonth, 1931) have each been suggested as of possible use in late stages. Operations for tightening a patulous urethra or an incompetent external sphincter may also have to be considered in a small group of selected cases.

f. Treatment of Urinary Calculi.—In this series calculi have been found in 7 cases, an incidence of 20 per cent. Of the factors concerned in their production, the most important in spinal cases are infection and prolonged recumbency; there has been no dietetic or vitamin deficiency, but an adequate diet with supplies of vitamin A is important. In all these cases the stones have appeared first in the kidneys; some have migrated to the ureters and bladder, but there is no case of primary vesical calculus.

The stones have been mainly phosphatic and they have been of the solid variety and not the 'mud' which sometimes collects in cases long recumbent and which may be passed when the patient can get up and about. Their formation is of serious import and affects the ultimate prognosis adversely. Their operative removal is indicated in cases where they are causing pain and where the patient appears likely to recover

from the paraplegia. The maintenance of a good output and an acid urine does much to prevent their formation.

PROGNOSIS

Whilst it would be wrong to draw rigid conclusions on the evidence of such small numbers, certain facts are apparent from a study of these cases from which useful inferences can be drawn about the prognosis in any individual case of spinal injury with bladder paralysis. The total mortality was 28·5 per cent up to two years from the injury; of the 10 deaths 5 were due to toxæmia, including urinary sepsis, 2 to pulmonary disease, 1 to multiple injuries, 1 to operation, and 1 to secondary carcinoma.

The factors which influence prognosis, apart from associated injuries, are the extent of the nerve lesion, its level, and the presence or absence of urinary infection. The first two cannot be affected by treatment, whilst the third can. The extent of the nerve lesion is a matter for the neurologist to assess, and it is often impossible for him to decide for a few days whether a lesion is complete or partial, but the lesions classified as complete have had a higher mortality than the incomplete, and lesions of the cord have been more lethal than those of the cauda equina. The following table gives the mortality in terms of the severity of the nerve lesion, its level, and of the two factors combined.

Lesion	*Number*	*Deaths*	*Mortality* per cent
Complete	11	6	54·5
Incomplete	24	4	16·6
Cord	16	7	43·7
Cauda equina	19	3	15·8
Complete cord	8	5	62·5
Incomplete cauda equina	16	2	12·5

The advent of urinary infection has an adverse effect not only on the immediate outcome, but also on the ultimate life of those who survive. Of the 25 survivors 18 had a more or less serious degree of infection which is likely to shorten their lives and make them less useful citizens. It is because the infection is usually introduced by improper treatment that so much stress has been, and should be, laid on it as a material factor in prognosis.

SUMMARY OF CONCLUSIONS

1. After paralysis of the bladder from spinal injury the only satisfactory methods of voiding are those of voluntary micturition, the periodic reflex of a cauda equina lesion, or by suprapubic cystotomy.

2. The main obstacle to the final attainment of a satisfactory act is urinary infection; others which may retard recovery are urinary leakage favouring pressure sores, and prolonged over-distension leading to muscle damage and fibrosis.

3. Urinary infection may cause death or permanent disability. It is introduced by urethral catheterization.

4. Urethral catheterization should be forbidden absolutely unless and until surgical facilities are perfect.

5. The relief of retention is not an urgent matter and is rarely necessary in the first twenty-four hours.

6. Overflow incontinence is a safe solution of the problem of retention, but may produce urinary dermatitis and pressure sores, especially in women.

7. If retention must be relieved on account of pain, the alternatives which are safer than a urethral catheter are: Suprapubic aspiration; Suprapubic catheterization; Suprapubic cystotomy. Suprapubic catheterization of the distended bladder offers an efficient method of treatment. It can be combined with tidal drainage after two days.

8. Manual expression is too hazardous and uncertain to be advised for general use.

9. To be satisfactory either for immediate or permanent treatment any suprapubic opening must be made high and water-tight.

10. The patient should be transferred to a special centre as soon as circumstances permit. Only at such a centre, or in a well-staffed and equipped hospital, should urethral catheterization be allowed.

11. Intermittent catheterization as a method of treatment should be reserved for mild cases and limited in any event to a period of two days. If there is no recovery after two days the case should be treated by suprapubic catheterization with subsequent tidal drainage.

12. Tidal drainage with an indwelling urethral catheter should only be used in a centre and by a staff who have special experience of the method. There should be no delay in replacing it by suprapubic catheterization if naked-eye inspection of the urine shows evidence of infection.

It is a great pleasure to express my thanks to Mr. R. Schranz of the Genito-Urinary Manufacturing Co. for his skill in producing the suprapubic catheter introducer and advancer, and to my house surgeons of the past four years for their part in the development of the tidal drainage apparatus.

REFERENCES

BELL, C. (1812), *Med.-Chir. Trans., Lond.*, **3**, 171.
BELLIS, C. J. (1940), *Surgery*, **8**, 791.
DENNY-BROWN, D., and ROBERTSON, E. G. (1933), *Brain*, **56**, 397.
DOUGLAS, JOHN (1723), *Lithotomia Douglassiana; or a New Method of Cutting for the Stone.* London.
FRANCO, P. (1556), *Traité des Hernies.* Lyons.
GOWLLAND, E. L. (1934), *Med. Pr.*, **188**, 81.
HOLMES, G. (1933), *Brain*, **56**, 383.
KIDD, F. (1919), *Brit. med. J.*, **1**, 397.
LAVER, C. H. (1917), *Guy's Hosp. Gaz.*, **31**, 71.
LAWRIE, R. S., and NATHAN, P. W. (1939), *Lancet*, **2**, 1072.
LEARMONTH, J. R. (1931), *Brain*, **54**, 147.

Ministry of Health, 1940. E.M.S./Gen./314.
MOTHERSILL, G. S., and MORSON, C. (1921), *Brit. med. J.*, **1**, 418.
MUNRO, D. (1936), *New Engl. J. Med.*, **215**, 766.
MUNRO, D., and HAHN, J. (1935), *Ibid.*, **212**, 229.
NESBIT, R. M., and GORDON, W. G. (1941), *Surg. Gynec. Obstet.*, **72**, 328.
RICHES, E. W. (1943), *Lancet*, **2**, 128.
STEWART, O. W. (1942), *Ibid.*, **1**, 287.
THOMSON-WALKER, J. W. (1917), *Ibid.*, **1**, 173.
THOMSON-WALKER, Sir J. W. (1937), *Proc. R. Soc. Med.*, **30**, 1233.
VELLACOTT, P. N., and WEBB-JOHNSON, A. E. (1919), *Lancet*, **1**, 733.
WALKER, K. M. (1913), *Ibid.*, **1**, 435.
WATKINS, K. H. (1936), *Brit. J. Surg.*, **23**, 734.
WINSBURY-WHITE, H. P. (1933), *Brit. J. Urol.*, **5**, 249.

A CASE OF FIBROMYOMA OF THE EPIDIDYMIS IN AN UNDESCENDED TESTICLE

BY GORDON GORDON-TAYLOR, C.B., O.B.E.

THE writer recently reported an adenoma of the epididymis in the pages of this JOURNAL (Gordon-Taylor and Ommaney-Davis, 1941). The following account concerns a leiomyoma of the epididymis with a considerable amount of fibrous tissue stroma.

CASE REPORT

H. M., aged 42, had an imperfectly descended testicle on the right side. The organ was of normal size; at its lower end was a firm ovoid tumour, about

FIG. 128.—Specimen of leiomyoma of globus minor of undescended testicle.

½ in. in diameter, firm and painless, which was said to have been present for six months (*Fig.* 128). The imperfect descent of the organ aroused a dire suspicion of malignancy in the mind of the writer, whose experience of malignancy in the undescended testicle has been disconcerting in its frequency. The organ was therefore ablated forthwith.

PATHOLOGICAL REPORT.—Testis with epididymis and cord. Attached to the globus minor is a firm, white tumour ½ in. in diameter, which on section shows a whorled appearance. Section shows a tumour composed of fibrous and muscular tissue (*Fig.* 129). Diagnosis—fibromyoma.

DISCUSSION

Leiomyoma constitutes the most frequent variety of the rare group of benign growths of the epididymis; 13 cases were collected by Friedman and Grayzel (1941), of which 2 were bilateral tumours. The case recorded here is unique in that it was situated in an undescended organ.

The history is usually obtained of a gradual, painless increase of an intrascrotal swelling, although occasionally intermittent pain may have been noted. In some of the cases there has been an antecedent history of gonococcal epididymitis (Héricourt, 1885; Terillon, 1886; and others); in Condamin's patient (1837) there was a history of scrotal injury three months before the appearance of the epididymal tumour.

The duration of the tumour is sometimes considerable; Spivack's patient (1935) gave a history of ten years, the tumour only increasing in size and becoming painful in the last two years; Foged's case (1939) volunteered a story of twelve years; Héricourt's patient (1885) had known of his tumour for seven years; Eisenstaedt's (1923) for five years; and the epididymal growth in Terillon's patient (1886) had not only been present for five years, but had even been painful.

The tumour is most frequently situated in the globus major or minor; it is rarely found in the corpus of the epididymis. The growth is round or ovoid, firm to stony-hard in consistency, nodular, and not usually tender. An associated hydrocele is said to be present in 50 per cent of the cases.

Correct diagnosis has only rarely been attained pre-operatively; the cases are often regarded as testicular neoplasms and submitted to orchidectomy. At the time of operation, the tumour has varied from the size of a pea to the volume of a mandarin orange.

On two occasions the patient has presented himself with a bilateral leiomyoma of the epididymis (Milner and Gilbert, 1939; Foged, 1939). In the case described by Milner and Gilbert an orchidectomy was performed on one side and an epididymectomy on the other.

FIG. 129.—Histological appearances of tumour of epididymis. The upper portion of the illustration exhibits the normal structure of the epididymis; the lower part shows smooth muscle cells and fibrous tissue

Some have regarded all myomata of the epididymis as inflammatory; others have denied an inflammatory origin. Rubaschow thought that myomata arose from the embryonic rests of the myotome and were not true tumours of the epididymis, only arising in close proximity to it. Patel, however, states that smooth-muscle cells are normally found in the epididymis and that the myoma originates in these cells.

There was no history in Thomson-Walker's case of the presence of a leiomyoma before the development of a myosarcoma; and no recurrence has ever followed operation. The appropriate form of surgical treatment should, therefore, be *epididymectomy*.

I am once again under a debt of obligation to my colleague, Dr. R. W. Scarff, of the Bland-Sutton Pathological Institute, Middlesex Hospital, for the microscopical report upon this tumour. The illustrations which accompany the paper are from the pen of my friend, Dr. E. P. Smith, to whom my very grateful thanks are also due.

BIBLIOGRAPHY

CONDAMIN, R. (1837), *Lyon méd.*, **56**, 103.
EISENSTAEDT, J. (1923), *Surg. Gynec. Obstet.*, **37**, 361.
FISCHER, W. (1932), *Zbl. allg. Path. path. Anat.*, **54**, 321.
FOGED, J. (1939), *Zbl. Chir.*, **66**, 1811.
FRIEDMAN and GRAYZEL (1941), *J. Urol.*, **47**, 475.
GOODHART, J. F., and GAY, J. (1887), *Trans. path. Soc. Lond.*, **31**, 310.
GORDON-TAYLOR, G., and OMMANEY-DAVIS, C. (1941), *Brit. J. Surg.*, **29**, 260.
HÉRICOURT, J. (1885), *Rev. Medicine*, **5**, 54.
MILNER and GILBERT (1939), *J. Urol.*, **43**.
SAKAGUCHI, Y. (1916), *Frankfurt Z. Path.*, **18**, 379.
SPIVACK, A. H. (1935), *J. Urol.*, **34**, 122.
STOUT, A. P. (1917), *Proc. N.Y. path. Soc.*, **17**, 129.
TERILLON, O. (1886), *Congr. franç. Chir.*, **1**, 582.

ORBITAL TUMOURS

BY A. E. ILES, O.B.E.
LECTURER IN OPHTHALMOLOGY IN THE UNIVERSITY OF BRISTOL
AND A. RENDLE SHORT
PROFESSOR OF SURGERY IN THE UNIVERSITY OF BRISTOL

A REMARKABLE monograph has recently been published by W. E. Dandy, of the Johns Hopkins Hospital, on the subject of orbital tumours. He has operated on a series of 25 cases, and described 6 others seen but not surgically treated. Only 20 per cent of these tumours were confined to the orbit; in 80 per cent they occupied both the intracranial cavity and the orbit. For that reason the operative procedure adopted was to make a curved incision at the hair-line above the forehead, then to open the skull by turning down a flap of the frontal bone, and to lift the frontal lobes of the brain, as in the operation for removal of pituitary tumours. The growth can thus be reached through the roof of the orbit, and very good access is obtained, even if it invades the cranial cavity. The mortality was only 4 per cent. The pathological examination of the tumours removed or studied showed 11 cases of dural meningioma, 5 cases of Schüller-Christian's disease, 4 gliomata, and 1 or 2 each of periosteal sarcoma, spindle- or round-celled sarcoma,

osteoma, and various other conditions. He condemns Krönlein's method of approach, because so often it does not allow room to deal with the intracranial extension.

The general impression conveyed by text-book descriptions of tumours of the orbit is that they are most commonly of a malignant nature and the outlook is very unpromising. Thus, in Swanzy's *Diseases of the Eye* it is stated that the primary tumours of the orbit may be cysts usually dermoid in origin, hernia cerebri, or solid tumours which " are in most instances malignant (sarcoma, endothelioma), but may be benign (exostosis, angioma, fibroma) ". In Sir Herbert Parsons's *Diseases of the Eye* it is said that orbital tumours are rare. " Benign growths include dermoid cyst, dermolipoma, angioma, osteoma, plexiform neuroma, meningo-encephalocele. . . . Malignant tumours of the orbit are usually sarcomata, though carcinoma derived from the lachrymal gland or by extension from the nasal mucous membrane also occurs. . . . Primary tumours of the optic nerve manifest themselves clinically as orbital tumours. . . . They may kill the patient by intracranial extension."

Several text-books state that angiomata are soft and compressible and increase in size when the patient strains.

According to fairly recent publications quoted by Dandy, tumours found in the orbit have been of a very varied kind. They include cavernous angiomata (three authors, 1 case each); teratoma (2 cases); cysts (2 cases); cholesteatoma (3 cases); myxosarcoma (1 case); neurofibromatosis (3 cases); and a hæmangio-endothelioma.

PERSONAL CASES

Our own experiences, though small, have differed widely from Dandy's and also from that of the older authors. We may, of course, have been unusually fortunate; the experience of others will act as a check-up in that respect. In our series the pathology was as follows :—

4 cases of hæmangioma (A.E.I., 2; A. R. S., 2).
3 „ „ intra-orbital cyst (all A. R. S.).
2 „ „ sarcoma (A. E. I.).
1 case of scirrhous carcinoma of the lachrymal gland (A. E. I.).
1 „ „ diffuse lipoma (A. R. S.).
1 „ „ unknown pathology (A. R. S.).
1 „ „ mixed lachrymal tumour (A. E. I.).
1 „ „ tuberculous orbital abscess (A. R. S.).

Of this series of 14 cases, therefore, only 3 were malignant. The youngest patient was 18 and the oldest 70.

The most interesting tumours were the *hæmangiomata*. The nature of the tumour may be quite unsuspected, or it may be indicated by a nævoid condition of the eyelids. It is surprising to find a hæmangioma presenting itself within the orbit as a firm, red, rounded, well-encapsulated tumour. All 4 cases in our series were of this character. The following is a typical history :—

Mr. A., aged 70, was referred to one of us (A. R. S.) by Mr. Cogan, of Tunbridge Wells. Patient had complained for five months of blurred vision of the left eye, and the conjunctiva became blood-shot. There was no pain. After a few weeks diplopia was noticed for near reading, not for distant vision. On examination there was definite proptosis, but there

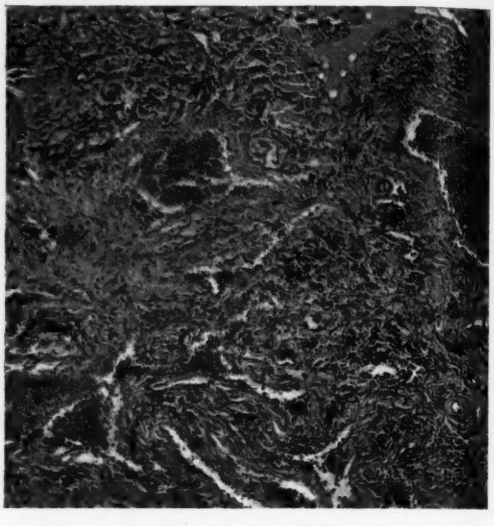


FIG. 130.—Hæmangioma of orbit. (× 120.)

was no pulsation. The vessels in the conjunctiva were engorged. A hard swelling could be felt at the lateral lower angle of the orbit, deep within the orbital cavity, and apparently attached to the bone. A month before, his medical adviser had been unable to discover any such swelling. A radiograph showed no bony changes in the orbit. An operation was performed, and the orbit opened by Krönlein's method of approach. When the lateral wall of the orbit was swung outwards, a well-encapsulated, dusky-red, firm swelling came into view, about the size of a large cherry or small walnut. It was not attached either to the eyeball or to the bony wall of the orbit, but it was dissected away with some difficulty from the ocular muscles and Tenon's capsule. On cutting across, the growth was firm, solid, and deep red in colour. The pathological report, by Dr. A. D. Fraser, was hæmangioma. The patient made a good recovery, except that there has been persistent diplopia. It is difficult to say whether this is due to injury to the external rectus muscle, or the sixth nerve, or both. The proptosis disappeared. (*Fig.* 130.)

Another case of hæmangioma was left with some weakness of the superior and external rectus muscles. The proptosis was cured. In a third case the tumour was wrapped round the optic nerve, by which it was grooved. The tumour was successfully removed by Krönlein's method, which gave good exposure; the only disability after the operation was a permanently dilated pupil.

The *intra-orbital cysts* were all three of different pathology. In one, a young man, the cyst lay far back in the orbital cavity, and contained clear fluid. One can only speculate as to its origin.

The only symptoms were marked unilateral exophthalmos and diplopia. It was operated on by Krönlein's method and shelled out quite easily. Two other cases, both in middle-aged men, were seen within a few weeks of one another, and on a superficial examination were very similar. In each case there was fluctuating swelling about the size of a walnut occupying the anterior half of the orbital cavity at the upper mesial angle, and presenting visibly above, and deep to, the lachrymal sac. One of these shelled out fairly easily and appeared to be an orbital dermoid. The other was all quiet when first seen, but by the time a bed could be found in hospital for him, it had become infected and several weeks' delay was necessary. It proved to be a mucocele of the frontal sinus, which had absorbed its bony floor and protruded into the orbit. Removal was difficult.

The *lipoma* gave rise to protrusion of the eye in a man of fifty-four. There were no other symptoms. Sarcoma was suspected. The orbit was exposed by Krönlein's operation, and a diffuse mass of fat, not definitely encapsulated, was dissected out.

There were 3 *malignant cases*. In one of these a large encapsulated sarcoma was found and removed. It recurred later in the parotid region. In another patient, a large mass was removed from the upper and outer part of the orbit. This proved to be a lymphosarcoma of low-grade malignancy. There was no recurrence six months later. In a third malignant case, a scirrhous carcinoma of the lachrymal gland was found. It was partly removed, but the posterior portion could not be reached. This was treated four days later with radium (960 mg.-hr.). After five years there was no recurrence and vision was 6/5, as before the operation.

In all the above cases we have found the Krönlein method of approach quite satisfactory, though it is helpful to obtain more room by including about 1 cm. of the upper lateral margin of the orbit along with the bony flap reflected. The bone falls back accurately into place, and the cosmetic result is good, with disappearance of the proptosis. Unfortunately, there may be some residual diplopia from paralytic strabismus. Possibly this may be remedied by further operation, to reattach the damaged lateral rectus muscle. In some cases this has not been recognized at the primary operation; it may be spread out as a flattened sheet of muscular fibres embracing the tumour, especially the hæmangiomata.

The case of *tuberculous abscess* was very kindly sent to us by Professor Lambert Rogers and Mr. Arnold Aldis, from Cardiff. A lad of 18 gave a history of protrusion of the right eye starting ten weeks ago. This led on to total blindness in the eye, and later a swelling was noticed over the right temple. The radiograph was normal. Aspiration of the temporal swelling, by Mr. Aldis, showed a tuberculous abscess. Krönlein's operation was performed, and another tuberculous abscess evacuated from within the orbit. There was no connexion between the two collections of pus, but the outer bony wall of the orbit was bare, and probably it was the seat of the tuberculous infection. It was thought possible that there might be a further extension of the abscess through the sphenoidal fissure inside the cranium. The case is too recent for the end-result to be known. (*Fig.* 131.)

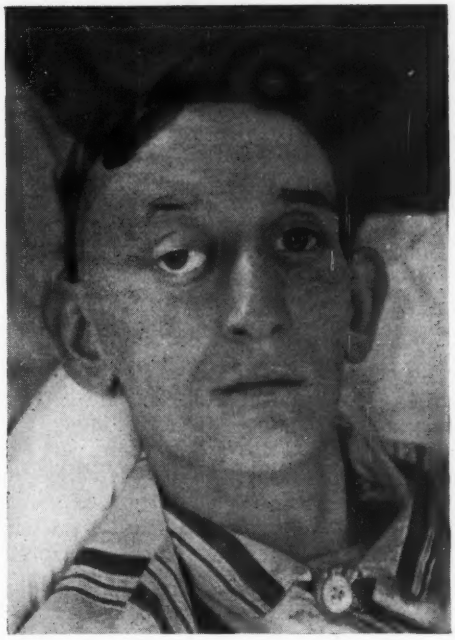


FIG. 131.—Unilateral proptosis due to tuberculous abscess of right orbit. There is also a tuberculous abscess of the temple.

One case remains to be mentioned. A woman aged 36 was referred to one of us (A. R. S.) by Mr. E. R. Chambers, suffering from proptosis of the left eye of two years' duration, associated with blindness due to papillœdema and hæmorrhages; only light-perception remained. No growth could be felt between the eyeball and the bony wall of the orbit. The radiograph was negative. We felt that it was doubtful if a Krönlein operation would sufficiently expose the cause of the proptosis in this patient, as it was probably far back and perhaps within the cranium, though there were no signs of intracranial pressure and an encephalogram was negative. We therefore sent her into the Burden Neurological Clinic under the care of Mr. W. Willway, who performed Dandy's operation upon her. The roof of the orbit was removed, but no growth could be found. It certainly was not intracranial; probably it lay below the optic nerve and so was inaccessible from above. Possibly Krönlein's approach might have revealed it. The patient made a good recovery, and as a result of the decompression of the orbit the eye returned to normal position. The sight improved to 2/24. There, was however, some

residual ptosis, and pulsating nystagmus on looking up.

SUMMARY

Thirteen cases of orbital tumour are mentioned, of which 4 were hæmangiomata. Only 3 cases were malignant, and in 2 of these there was no recurrence when last seen. In none of the 13 was there an intracranial extension. In 12 cases Krönlein's operation was performed, and in 1 case Dandy's method of decompression was employed. All the patients were improved as a result of the operation, but one tumour recurred, and ocular palsies followed in several others. There was also a case of tuberculous abscess.

In our opinion, intra-ocular tumours which are in the outer and lower parts of the orbit are well exposed by Krönlein's method, as are also tumours and cysts within the cone of the muscles. If intracranial extension is suspected, Dandy's approach is indicated.

WEBBING OF THE NECK, WITH TURNER'S SYNDROME IN THE MALE

By Squadron Leader GEOFFREY FLAVELL, Surgical Specialist, R.A.F.V.R.

HISTORY

In 1883 Kobylinski first described the condition of webbed neck, to which Funke in 1902 gave the name " pterygium colli ". Bussiere in the same year reported it again in a Hindu boy of 12 years. These cases displayed an extraordinary web of skin and subcutaneous tissue stretching like a bat's wing from the mastoid processes to the shoulder-tips. In males the condition occurred as an isolated congenital phenomenon; but Funke noted that in his patient, a girl of 15, there was an associated absence of secondary sexual characteristics.

Frawley in 1925 reported two sisters of 12 and 16, a woman of 28, and a girl of 7 in whom there was also webbing of the axillary folds.

Chandler in 1937 reviewed the literature and described an operation which he had devised for removal of the webs in two small boys with simple webbing.

In 1938 H. H. Turner described 7 cases (to which he subsequently appended a further 3) of what he called " pterygonuchal infantilism ". All were female. They displayed the triad—now known as Turner's syndrome—of webbing of the neck, an increased carrying angle at the elbow, and sexual infantilism. In all these the cervical spine was unaffected and the mentality was normal, but the secondary sexual characteristics were underdeveloped, breasts and genitalia being hypotrophic, and menstruation scanty or absent. Up to 1938, a total of 40 such cases had been reported, chiefly from French and German sources.

In 1941 Sharpey-Schafer contributed another one, also female, displaying the Turner triad. Here a certain degree of childishness was present, and he remarks upon an accompanying kyphoscoliosis. The blood-chemistry was normal, and hormone therapy unavailing. His patient eventually died of miliary tuberculosis.

Nowhere in the literature has an example of the Turner triad (webbing, plus cubitus valgus and sexual infantilism) been recorded occurring in a male subject.

AETIOLOGY

A variety of theories have been advanced, both with regard to simple webbing and to Turner's syndrome. Nageotte-Wilbouchewitch (1934) believed that it was a pure atavism, and remarked that it occurred naturally in the chimpanzee.

MacCollum (1938) considers that webbing might arise at the 3rd fœtal month, when ventral and dorsal surfaces of the neck are long, the mastoid process being either lateral or in direct vertical line with the region of the acromion, and the skin over the lateral surfaces of the neck undergoes shortening. As the shoulders develop it is possible for the skin to remain shortened, and for a web to be left.

Turner (1938) himself thought his cases corresponded to the Lorain-Levi type of dwarfism, and that the anterior pituitary was responsible.

Even the bankrupt view that the webs were due to amniotic adhesions has been expressed.

DIFFERENTIAL DIAGNOSIS

The differences between simple webbing and Turner's syndrome proper have already been outlined, and there is little risk of so bizarre an entity passing unrecognized. Such a condition as Sprengel's deformity is easily distinguishable by the characteristic high scapulæ and omovertebral bones.

In 1912, however, Klippel and Feil described a syndrome (of which some 133 cases have since been collected) in which synostosis of some or all the cervical vertebræ was present, associated with cervical spina bifida, and in which a shortened neck with a low hair-line and limitation of movement produced an appearance not dissimilar to that of pterygium colli. The condition was produced by a failure of union between the bilaterally formed centres of ossification in the 2nd, 3rd, and 4th cervical bodies, with an accompanying absence of the intervertebral discs. Facial asymmetry, dorsal scoliosis, mirror movements, and torticollis may also be associated.

None of these things are described in association with Turner's syndrome.

A CASE OF TURNER'S SYNDROME IN A MALE

The patient, an aircraftman aged 21, was referred to the writer on account of painful feet. He was of normal intelligence and a little below the average in physique. From the posterior aspect of both auricles a ridge of skin and subcutaneous tissue curved back to the mastoid processes, and passed thence in a bold web with a gentle concavity down to the region of the acromion (*Fig.* 132). The web could be taken between the fingers and flapped about. Down the whole length of the right web was a linear scar made by an exploration carried out when the patient was three years old. The facial skin was drawn taut, and the angles of the eyes, nose, and mouth were pulled downwards. The chin was receding, and also had the appearance of being drawn back by the tight skin. By contrast, the skin of the nape of the neck was loose and even redundant. The hair-line was low. There was no real shortening of the neck, but the base appeared wider than is normal.

Definite cubitus valgus was present, the carrying angle of the forearms being 25°, as opposed to a normal angle of about 15°. There was also some kypho-scoliosis, as in Sharpey-Schafer's case, with prominence of the sternum; and the patient had 3rd-degree bilateral claw-feet (*Fig.* 133).

His beard was scanty, and he found shaving once every three days to be enough. On the chest there was no hair, and almost none in the axillæ. The pubic hair was of female distribution, and the hips were wide. The penis was of normal size, but both testicles were hypoplastic, being about one-third of normal. He had been married three months, and said that erections and emissions were normal.

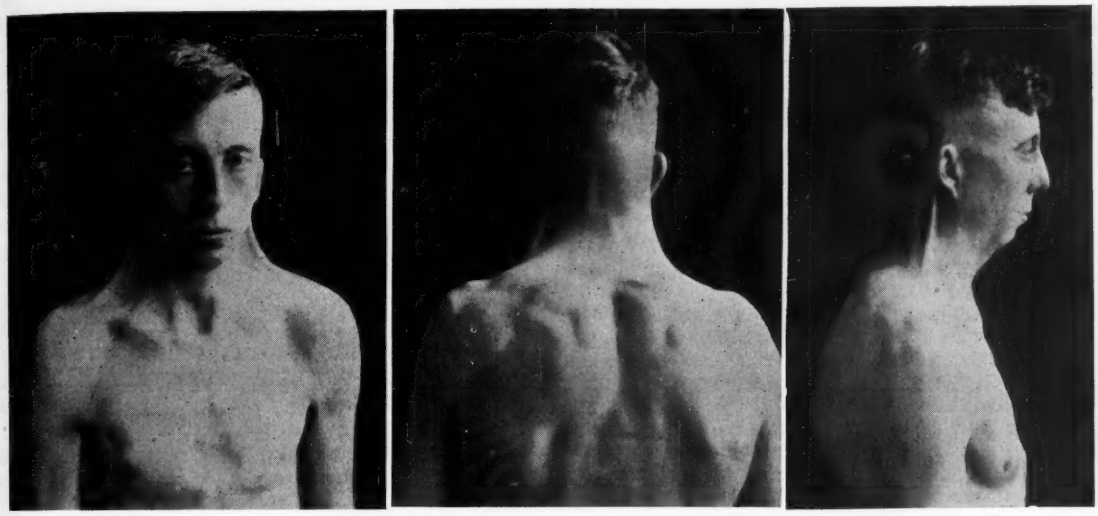
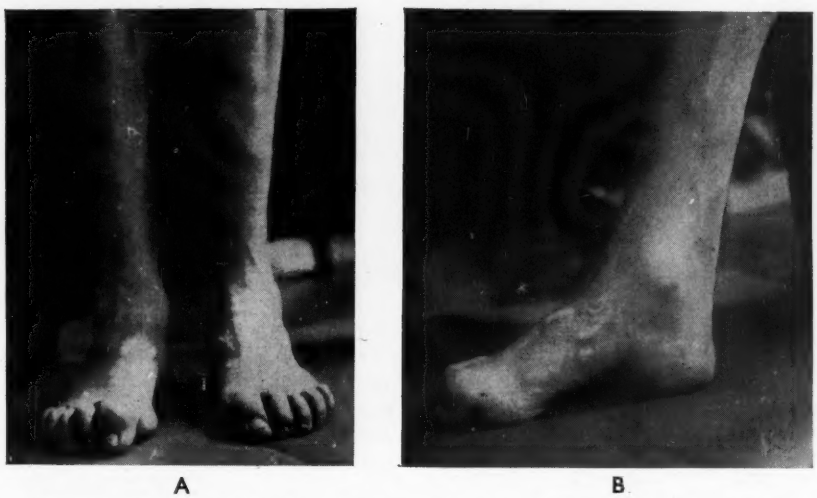


FIG. 132.—Photographs of patient showing front, back, and side views.



A B

FIG. 133.—Photographs showing: A, Bilateral claw-feet; B, Lateral view of right foot.

A radiograph of the cervical region showed a failure of union of the 5th cervical neural arch in the midline. No other abnormality was present, there being neither synostosis nor loss of the intervertebral discs. There was no limitation of movement of the neck, apart from the slight constraint of the webs themselves. And nowhere was there evidence of any neurological change.

In short, the case displays all the classical requirements of Turner's syndrome, except that the patient is a male.

His past history was irrelevant, but in his family history, which included normal grandparents, he revealed that his father had an infantile left hand. This is of interest, as a possibly analogous developmental failure, and because none of the other cases described have had any significant family history.

OPERATION.—At the patient's request, it was decided (for æsthetic as well as psychological reasons), to remove his webs. He asked also that both sides be done at once. Chandler describes an ingenious little plastic operation which he used on his two cases in America, and it was decided to employ this on the left side. The presence of so much scar tissue in the opposite web rendered it unsuitable on the right.

The operation was carried out with the patient lying first on his left side, and then on the right, a small sandbag being placed under the head and the uppermost arm being drawn down by an assistant to throw the webs into maximum prominence.

On the right side the longitudinal scar was first excised, and the skin and superficial tissues mobilized by undercutting. When this had been done, a apart. Closure was then obtained by reversing the relative positions of the angular flaps so formed (*Fig.* 134). This produces a vertical lengthening and a horizontal shortening, and so obliterates the web. Horsehair sutures were employed as before, and bulky dressings

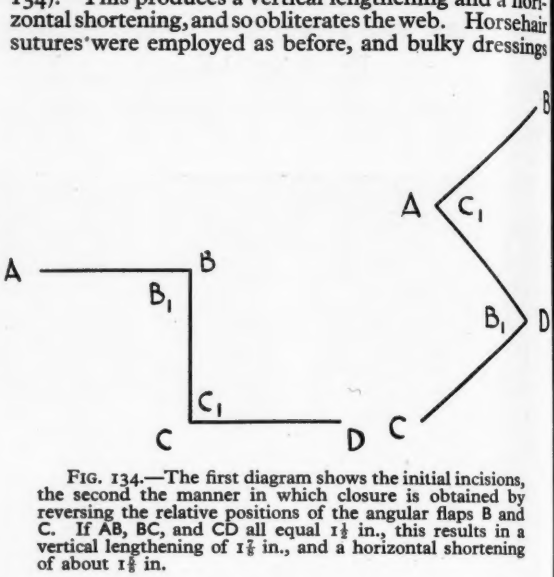


FIG. 134.—The first diagram shows the initial incisions, the second the manner in which closure is obtained by reversing the relative positions of the angular flaps B and C. If AB, BC, and CD all equal 1½ in., this results in a vertical lengthening of 1⅞ in., and a horizontal shortening of about 1⅛ in.

applied to both sides of the neck. Subsequently massage, neck exercises, and light therapy were prescribed to maintain mobility of the scars and of the facial and anterior cervical skin. The patient was

FIG. 135.—Photographs showing the appearance after operation.

fibrous keel was left running from the mastoid process to the shoulder-tip. All this tissue was removed, until the normal neck contour was restored. The superfluous skin was then cut from the posterior flap, so that no encroachment would be made on the tauter facial skin, and the wound closed with interrupted horsehair sutures which were removed on the third day.

The left side was treated by Chandler's method. A longitudinal incision was again made, and this time no fibrous tissue was encountered, the web being purely cutaneous. At the junction of the lower and middle thirds of this incision, two horizontal cross-incisions were made about 1½ in. long, and about 1 in. satisfied with the final result, and thought the right side, if anything, better than the left (*Fig.* 135). He left hospital after a week.

DISCUSSION

There is little reason to doubt that this case disproves Turner's belief that his syndrome occurs exclusively in the female. The claw-feet seen here have not previously been described, and since neurological factors, including poliomyelitis and spina bifida occulta, have been invoked to account for them, it is interesting to note that this

patient, while having no history of the former, seems to have a cervical spina bifida occulta. This, in turn, is reminiscent of Klippel-Feil's syndrome, which the case does not resemble in any other particular, except in having a low hairline and kyphoscoliosis. These similarities, though tenuous and unessential, must arouse some speculation as to whether there may not be, after all, a relationship between the two conditions.

There does not appear to be any sound basis for regarding this complex association of orthopædic, cutaneous, and gonadal abnormalities as a pituitary dysfunction, which is the solution suggested by Turner. Nor can a theory of atavism reasonably account for allied deformities for which there are no phylogenetic homologues. But all the facts point to a fœtal developmental failure (for whose mechanics MacCollum furnishes a partial explanation) of the same kind as, let us say, anencephaly, or ectopia vesicæ. And since the Klippel-Feil syndrome is a precisely similar failure, involving the same region, it would be surprising indeed if a few points of similarity, or deficiencies in common, did not occur.

I am much indebted to Air Commodore Geoffrey Keynes and to Dr. Parkes-Weber for their help in preparing this note.

REFERENCES

ALBRIGHT, F. (1936), *Endocrinology*, **20**, 24.
BUSSIERE, J. A. (1902), *Ann. Hyg. Med. colon.*, **5**, 686.
CHANDLER, F. A. (1937), *Amer. J. Dis. Child.*, **53**, 798.
DEBRUIN, M. (1928), *Ibid.*, **36**, 333.
FRAWLEY, J. M. (1925), *Ibid.*, **29**, 799.
FUNKE (1902), *Dtsch. Z. Chir.*, **63**, 162.
GARDNER, W. V. (1940), *Proc. Soc. exp. Biol., N.Y.*, **45**, 835.
GILMOUR, J. (1941), *J. Path. Bact.*, **53**, 117.
KOBYLINSKI, O. (1883), *Arch. Anthrop.*, **14**, 343.
MACCOLLUM, D. W. (1938), *New Eng. J. Med.*, **219**, 251.
NAGEOTTE-WILBOUCHEWITCH, M. (1934), *Bull. Soc. Pediat. Paris*, **32**, 683.
RECHTMAN, A. M., and HORWITZ, M. T. (1940), *Amer. J. Roentgenol.*, **43**, 66.
SHARPEY-SCHAFER, E. P. (1940), *Lancet*, **1**, 161.
— — (1941), *Ibid.*, **2**, 559.
— — AND SCHRIRE, I. (1939, a), *Quart. J. Med.*, **8**, 195.
— — — — (1939, b), *Clin. Sci.*, **4**, 185.
TURNER, H. H. (1938), *Endocrinology*, **23**, 566.

BILATERAL PULMONARY HYDATID CYSTS*

BY A. L. D'ABREU
LIEUT.-COLONEL, R.A.M.C.
AND LAMBERT ROGERS
SURGEON CAPTAIN, R.N.V.R.

HYDATID disease is met with more often in South Wales than in most other parts of the British Isles. The incidence is maximal in the industrial districts, and has been commented upon in an excellent report by Dr. Nancy Howells, of the Welsh Board of Health (1938). Within the last few years we have had in the Surgical Unit at Cardiff examples of the disease in liver, lung, brain, and spine. Pulmonary cases have already been reported by one of us (A. L. d'Abreu, 1938), but the following is the first example of a bilateral pulmonary infection to be treated in this Unit. The case is that of a young man, who, despite the somewhat extensive involvement of both lungs, made a satisfactory recovery following two-stage operations on each side of the chest.

CASE REPORT

An underground haulier, aged 19, was admitted to the Cardiff Royal Infirmary on June 12, 1939. For four months he had complained of pain in the right side of the chest and had steadily lost weight. A month before admission he had considerable hæmoptysis and breathlessness on exertion and was seen by Dr. H. Trail, of the Welsh National Memorial Association, who referred him with the diagnosis of, " two hydatid cysts of the right lung and one of the left lung ".

X-ray examination revealed two large cysts in the right lung, one being in the parahilar region, and one cyst in the left lung (*Fig.* 136).

It is of interest to note that though he worked underground he lived in a sheep-farming area and kept greyhounds which lived in the house with him.

ON EXAMINATION.—His general condition was fair. In spite of the radiological appearances there were no notable physical signs in the chest. There was no hepatic enlargement and the cardiovascular system was normal.

Blood.—The hydatid complement-fixation test was positive. The blood contained only 1 per cent of eosinophils.

1ST OPERATION (A. L. d'A., June 27).—Under local anæsthesia the posterolateral portions of the right 6th and 7th ribs were resected subperiosteally and a pack of gauze soaked in iodine placed against the parietal pleura. The wound was closed lightly.

After this operation the hæmoptysis, which had continued daily since admission, increased somewhat.

2ND OPERATION (A. L. d'A., July 6).—Under local anæsthesia the wound was reopened and dense adhesion between the parietal and visceral pleura confirmed. Before an incision was made into the cyst,

* From the Surgical Unit, the Welsh National School of Medicine, Cardiff.

5 c.c. of 3 per cent formalin were slowly injected into the cavity and no coughing resulted. The cyst was widely opened and a typical endocyst lining easily removed and with little bleeding. The cavity was lightly packed with gauze. Typical scolices were identified in a wet-film smear made from scrapings of the wall of the endocyst.

PROGRESS.—Convalescence was rapid and all hæmoptysis ceased. The packing was removed entirely fifteen days after operation and thereafter the wound healed rapidly.

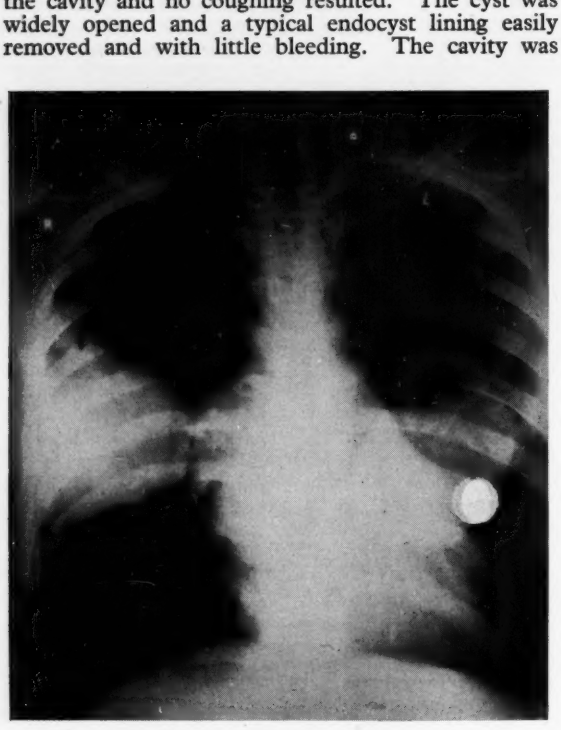


FIG. 136.—Radiograph showing two large cysts in the right lung and one cyst in the left lung.

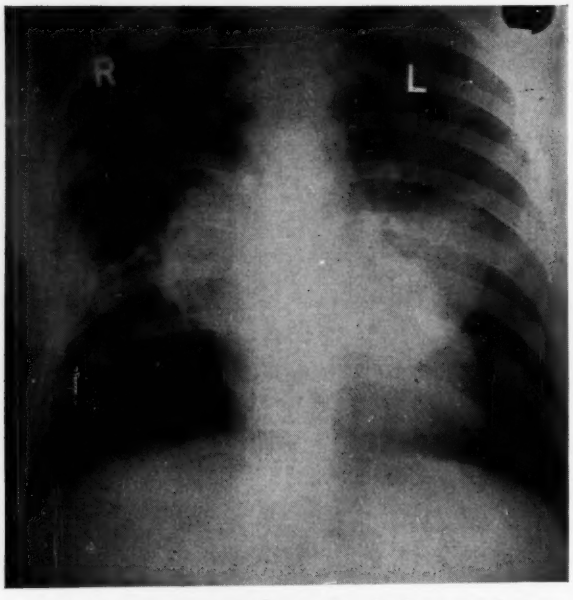


FIG. 137.—Radiograph taken 1 month after operation showing remains of the adventitious false ectocyst.

A radiograph taken on Aug. 8, one month later (*Fig.* 137), shows the remains of the adventitious false ectocyst. The right parahilar cavity is still present and at this stage hæmoptysis was again in evidence. It may be noted here that no attempt was made to drain this parahilar cyst, which ultimately was cured by spontaneous evacuation. Its disappearance will be noticed by a study of *Fig.* 138.

The patient was kept under observation and re-admitted to the Surgical Unit on April 17, 1940. At this time he complained of no symptoms other than pain in the left shoulder. There had been no hæmoptysis for several months and no cough.

3RD OPERATION (L. C. R., April 23).—Under local anæsthesia a portion of the posterolateral aspect of the seventh left rib was resected subperiosteally, the periosteum sutured above and below to the overlying muscles, an iodine pack placed against the parietal pleura, and the wound loosely closed.

4TH OPERATION (L. C. R., May 7).—Under local anæsthesia after 2 per cent formalin had been injected into the cyst the whole endocyst was removed and the cavity lightly packed with gauze.

PROGRESS.—The packing was replaced by a tube, which was discarded seventeen days after operation and the wound rapidly healed. He was discharged on June 3 symptom-free.

X-ray films taken four months later (*Fig.* 138) show lung healing with little residual fibrosis and rib regeneration on both sides.

Inquiry (March 24, 1943) as to his present condition reveals the fact that he is well, has gained weight, and has been following his occupation at the local colliery without interruption since his discharge.

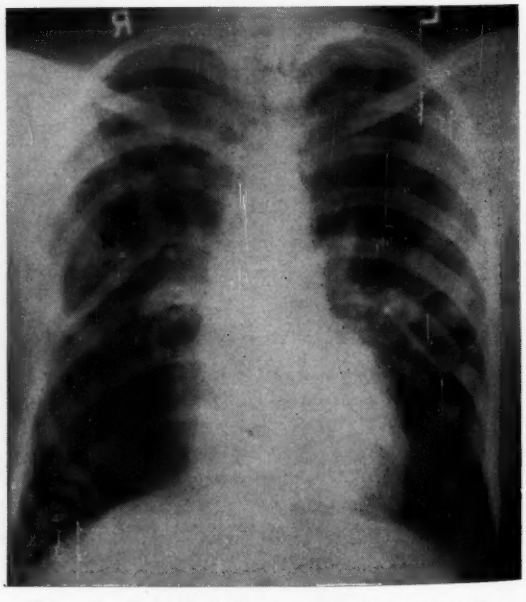


FIG. 138.—Radiograph demonstrating the spontaneous evacuation of the parahilar cyst.

COMMENTS

Next to the liver, which has been called the first filter, the lungs (the second filter) are the commonest site for the occurrence of hydatid cysts (Arce, 1941). Among 1350 cases of hydatid disease in Australia and New Zealand collected by

the Australasian Hydatid Registry, there were 250 classified as lung cysts; 15 of these were bilateral. Reporting these, H. K. Christie (1938), added an additional case, making in all 16, with a mortality of 25 per cent; 7 of the 16 cases were children under 8; of the adults, males predominated. Bilateral cases have also been referred to by Th. Shrire (1938), J. Arce (1941), A. Hope Gosse (1942), and others.

CONCLUSIONS

1. Bilateral lung infestation is not common. This is only the second example we have encountered in South Wales and the first bilateral case we have operated upon, though in the two years preceding the admission of this patient one of us (A. L. d'Abreu) treated 5 cases of pulmonary hydatid disease, 2 by drainage and cyst excision, and 3 by one-stage lobectomy.

2. Deep-seated parahilar cysts may evacuate themselves spontaneously, as happened in the case of this patient. It is probable that the hæmoptysis resulted from ulceration of this deeply placed cyst into the bronchial wall.

3. The use of local anæsthesia lessens the danger of flooding the bronchial tree with the fluid contents of the cyst: if such an accident should occur, a conscious patient is in a far better position to assist in the expectoration of the fluid.

4. The bilateral pleural adhesions produced in performing the two-stage operation on either side do not appear to have embarrassed the patient in any way.

REFERENCES

D'ABREU, A. L. (1938), *J. int. Chir.*, **3**, 1.
ARCE, J. (1941), *Arch. Surg., Chicago*, **43**, 789.
CHRISTIE, H. K. (1938), *Aust. N.Z. J. Surg.*, **8**, 373.
HOPE GOSSE, A. (1942), *Brit. J. Radiol.*, **15**, 92.
HOWELLS, N. (1938), Annual Report of the Chief Medical Officer of the Ministry of Health.
SHRIRE, TH. (1938), *S. Afr. med. J.*, Dec., reprinted in *J. R. nav. med. Serv.*, 1940, **26**, 43.

POPLITEAL ANEURYSM
WITH REPORT OF A CASE

BY AIR COMMODORE G. L. KEYNES, CONSULTING SURGEON, R.A.F.V.R.
AND SQUADRON LEADER M. P. MOREL, SURGICAL SPECIALIST, R.A.F.V.R.

ALTHOUGH popliteal aneurysm is the commonest form of peripheral aneurysm, examples are only rarely seen. Autopsy records as to the frequency of popliteal aneurysm are misleading, since the popliteal fossa is not examined as a routine.

Theis (1937) remarks that when the sac is small diagnosis is difficult, and the symptoms of intermittent claudication and coldness of the foot may overshadow the unusual findings in the popliteal fossa. As a rule the popliteal fossa is carefully examined only when serious complications are produced by advanced stages of the aneurysm. This occurred in the case here described.

Flemming (1939), in recording an interesting case of bilateral popliteal aneurysm, contrasts the dire result of spontaneous thrombosis of one aneurysm in which gangrene of the leg ensued, with the successful result of surgical treatment on the other side.

CASE REPORT

C. P., male, aged 55, arose at 4 a.m., and while at stool developed a sudden excruciating pain in the right leg and foot. The foot immediately became cold, pale, and continuously painful.

In the history there is no record of injury. While in France in 1917 he contracted gonorrhœa, for which he was treated in hospital, and has had no referable symptoms since. His blood-Wassermann and Kahn reactions were found to be negative at the present time. He was again in France in 1939–40, and during this time he found that he had to stop every now and then while going up hill, because of cramp in the right leg. After medical examination he was excused route marches. He was told that his symptoms were due to muscular rheumatism. One year ago he was again examined because of pain in the right leg, but nothing abnormal was found. During the last year he has had to sit with the right knee more or less extended as otherwise it was painful.

His three brothers and two sisters are well. His one son developed disseminated sclerosis at 20 years. His habits are temperate as regards alcohol; he smokes thirty cigarettes each day. His occupation for the twenty years preceding 1939 was that of cinema manager.

The patient reached hospital eleven hours after the onset of symptoms of vascular occlusion. The swelling behind the knee had been noticed that morning. On examination the right foot was found to be cold and the toes pale. No pulsation was discovered in the posterior tibial or dorsalis pedis arteries of either foot. Sensation was diminished below the right knee, and absent in the toes. Occupying the popliteal fossa was a hard, pulseless, silent swelling. Its upper and lower limits could not be determined. The limb was swollen below the right knee, being 1 in. greater in circumference than the other side. Further examination revealed a pulsating swelling with a systolic bruit just below the inguinal ligament on the right side. This second fusiform aneurysm involved the common femoral artery and was 2 in. long. It is shown in *Fig.* 139.

The blood-pressure was 150–90 mm. Hg. Apart from occasional extrasystoles, the heart was normal on clinical examination. Subsequent radiography of

the chest revealed no intrathoracic aneurysm, and of the right leg showed no radio-opaque vessels.

A diagnosis of a femoral and of a popliteal aneurysm was made, with either thrombosis or rupture of the

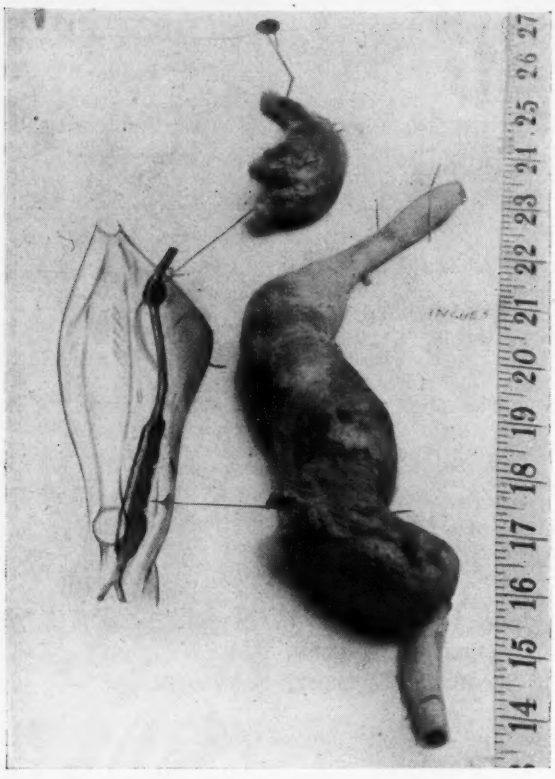


FIG. 139.—The two aneurysms are shown. The upper involved the bifurcation of the common femoral artery, the lower (popliteal) aneurysm extended into Hunter's canal. The accompanying diagram indicates their relative sites.

latter. Immediate exploration of the popliteal fossa was decided upon, in order to attempt to re-establish the collateral circulation which was considered to be compressed between the tumour and the swollen walls of the popliteal fossa.

Spinal anæsthesia, using 3 c.c. of duracaine, produced vasodilatation in the left leg, but none in the right. No tourniquet was used. The aneurysm was found to be thrombosed, and excision of the lower half of the aneurysm was performed. The upper part of the aneurysm was seen to extend through the opening in adductor magnus, thus involving the terminal part of the superficial femoral artery. The wound was closed, and the leg kept cool with ice-bags slung from the cradle.

Gangrene of the foot ensued, and six days later exploration of Hunter's canal showed that the femoral artery was thrombosed up to the apex of Scarpa's triangle. The femoral artery was ligatured at this point and a mid-thigh amputation performed. The aneurysm was subsequently dissected out of the limb and joined to the part previously removed. It measured 5½ in. long and was 2 in. in diameter, as can be seen in *Fig.* 139.

Five weeks later it was decided to remove the upper aneurysm, as, besides its intrinsic danger, it interfered with limb fitting. The external iliac artery was first ligatured, the branches from the aneurysm were secured, and the aneurysm excised. This produced no clinical alteration in the circulation in the stump.

PATHOLOGY.—Dr. A. H. T. Robb-Smith examined parts of the superficial femoral artery and of the wall of the aneurysms. (Section reference, R.I.S.H. 3109/42.) He reports as follows: "The femoral artery is occluded by thrombus, and the appearances would suggest that it is ante-mortem in type. There is quite a considerable degree of intimal thickening with fatty deposition: the changes of atheroma. In addition, at one or two points this intimal thickening becomes so marked as to cause considerable flattening and narrowing of the media, and at one place there is a definite break in the internal elastic lamina. The media itself is not entirely normal, and there is an increased vascularization and some degree of fatty deposition in the media. The adventitia shows no abnormality, nor do the vessels in the neighbourhood.

"The two portions of the aneurysms are considerably disorganized, but once again one can make out fair evidence of atheromatous changes in the intima, and extreme atrophy of the media, with breaks in the internal elastic lamina, and but little change in the external elastic lamina.

"At one point one can make out a zone of calcification, but whether this is part of the intimal atheromatous change, or represents a portion of medial calcification, one cannot be certain.

"I think one can say from these appearances, quite definitely, that there is no suggestion of any luetic change, and that they would all appear to be consequent on an atheromatous process with secondary rupture of the internal elastic lamina and medial degeneration. There is some medial change probably corresponding to that seen in Mönckeberg's sclerosis, but that these are atheromatous aneurysms I think there is no doubt whatever."

DISCUSSION

Aetiology.—Mills and Horton (1938), in a study of 596 cases, found syphilis present in less than 10 per cent of patients with an extrathoracic aneurysm. In this case no other aetiological factor, except atheroma, could be demonstrated.

Diagnosis.—Upon the diagnosis of popliteal aneurysm operative treatment should be undertaken with the intention of obliterating the aneurysm.

The diagnosis is simple when classical signs are elicited from a swelling in the popliteal fossa. Yet popliteal aneurysm may not be palpable and still cause gangrene, as in the case described by Leriche and Jung (1934). In this case a lumbar sympathectomy was performed before the correct diagnosis was reached.

The difficulty in diagnosis is further shown by the following personal case, in which the diagnosis proved to be thrombo-angiitis obliterans, and not popliteal aneurysm as was first supposed:—

H. A., male, aged 32, complained of severe pain in the left leg and foot, and had signs of vascular occlusion in the left leg. The symptoms had commenced six weeks previously when he noticed coldness of the left foot and nocturnal pain in the left leg. Intermittent claudication was present. The pain had suddenly become worse on the day of admission.

The posterior tibial and dorsalis pedis arteries were only palpable on the unaffected side. Otherwise no abnormality was found in the vascular system on clinical examination.

The popliteal fossa was examined, and although no swelling could be felt, there was a well-marked systolic bruit over the course of the popliteal artery.

An aneurysm was suspected; arteriography was not considered advisable since it might precipitate a thrombosis. The popliteal fossa was explored and the popliteal artery was found to be normal in appearance. The wound was closed. Later a lumbar sympathectomy caused improvement in the circulation in the leg. The bruit may have been caused by a 'roughening' of the intima.

Treatment.—Hæmorrhage and gangrene were so much feared before the time of Hunter that amputation for popliteal aneurysm was frequent. In the pre-antiseptic period the non-operative methods, namely, digital compression, flexion, and Reid's method (elastic bandage) resulted in failure in over half the cases.

In 1785, and only six months apart, Desault and Hunter both practised and advocated the ligature, which became an acknowledged method of treatment.

In one series of 42 cases of Hunterian ligation recorded in the antiseptic period there was a recovery rate of 87 per cent.

Matas (1920) described the results of 154 cases of popliteal aneurysm treated by his method; there was 1 death and there were 8 cases of gangrene in this series. Matas advocates the simplicity and security of the intrasaccular method as compared with excision of the sac. According to Matas, spontaneous gangrene occurs more frequently with thrombosis of the popliteal variety than with any other aneurysm.

The special danger of popliteal aneurysm may lie in the liability of flexion of the knee detaching clot from the aneurysmal wall, embolism occurring at the bifurcation of the popliteal artery. Spontaneous cure by gradual thrombosis is rare; more often sudden thrombosis takes place and is followed by gangrene of the limb.

CONCLUSIONS

1. Popliteal aneurysm is liable to be overlooked as a cause of peripheral vascular disturbance.

2. Spontaneous thrombosis in a popliteal aneurysm resulted in gangrene of the leg.

BIBLIOGRAPHY

COOKE, A. B. (1939), *West. J. Surg.*, **47**, 404.

DIAMOND, S., and DURHAM, W. R. (1940), *Med. Bull. Veterans' Adm., Wash.*, **17**, 78.

FLEMMING, C. (1939), *Lancet*, **1**, 322.

HARDY, A. G., and DENHAM, H. E. H. (1940), *Guy's Hosp. Rep.*, **90**, 244.

HARLEY, H. R. (1940), *Ibid.*, 255.

KIMPTON, A. R., and SANDERSON, E. R. (1939), *New Engl. J. Med.*, **220**, 146.

LERICHE, R., and JUNG, A. (1934), *Lyon chir.*, **31**, 182.

MATAS, R. (1920), *Surg. Gynec. Obstet.*, **30**, 456.

— — and KEEN, W. W. (1909), *Surgery*, **5**, 347, Philadelphia.

MILLS, J. H., and HORTON, B. T. (1938), *Arch. intern. Med.*, **62**, 949.

MOURE, P., and MEGNIN, J. (1932), *Ann. Anat. path. med.-chir.*, **9**, 805.

THEIS, F. V. (1937), *Surgery*, **2**, 327.

WELLS, A. H., COBURN, C. E., and WALKER, M.A. (1936), *J. Amer. med. Ass.*, **106**, 1264.

THE MALIGNANCY OF TESTICULAR CANCER IN MAN AND DOGS

BY J. R. M. INNES

MEDICAL RESEARCH DEPARTMENT, IMPERIAL CHEMICAL (PHARMACEUTICALS) LTD., BLACKLEY, MANCHESTER

Malignancy of Testicular Tumours in Man.—There are apparently two opposed points of view on this question: the first is that testicular cancer is a highly malignant neoplasm; the second is that it is relatively benign, and that simple castration with or without irradiation is therefore all that is required for adequate treatment. It is possible that until sufficient data covering a large series of cases over a period of years is obtainable the truth will not be forthcoming, but it seems a remarkable feature that such divergent views do exist. They might both be partly right, and some other factors such as selection of cases may have contributed to these varied opinions; from this standpoint work on the animal aspect might be of great value.

The development of malignancy of testicular tumours in man coincides with spread along the lymph-paths to an intra-abdominal focus in the para-iliac and para-aortic lymph-nodes. The inguinal nodes are not involved until the tumour spreads locally by continuity beyond the confines of the tunica to the scrotum. The lungs may be involved secondarily to lymph-nodal metastases by lymphatic or blood spread, while direct hæmatogenous spread to the lungs from the primary tumour is said to be a feature of the chorion-epithelioma—Dew (1925). The teratoma testis is often accepted as highly malignant, seldom failing to yield metastases and kill the host (Willis, 1934), but there seems to be a difference of opinion regarding the malignancy and prognosis of testicular tumours as a whole. It has been said, on the one hand, that malignant forms rarely break through the lymphatic barrier, although autopsy records have often shown

widespread metastases in the liver and lungs (Dew). Chevassu (1906) found an ultimate mortality of 81 per cent in 100 cases treated by orchidectomy, and Tanner (1922) stated that "few cases of malignant disease have a worse prognosis than tumours of the testis"; out of 465 follow-up cases recorded in the literature only 5½ per cent appeared to live for four years or more. Hinman (1933) advocated strongly the radical operation, for which he claimed a 20 per cent cure compared with 6 per cent after orchidectomy. Walker (1935) stated that "orchidectomy fails as a means of cure and is even more irrational than simple removal of the breast for mammary carcinoma". MacKenzie and Katner (1939) state that practically all new growths of the testis metastasize early and extensively both by the lymph- and blood-stream, and that the average time from the onset of symptoms until the demonstration of metastases is about 2 years 4 months. Opposed to these views might be placed the records of Cairns (1926), who found that there was little difference between the rate of recovery after the radical operation and castration (33·3 as against 31·2 per cent). Gordon-Taylor and Till (1938) suggested that prognosis was not as bad as was generally thought, and Payne (1938) strongly disapproved of the hopeless outlook which has been gradually adopted regarding testicular tumours. In his series of 38 cases (2 died from the operation and were untraced), all of which were treated by orchidectomy (a few by radiotherapy in addition), no fewer than 15 showed a cure rate of 5 years or over. He suggested that "malignant disease of the testicle had become 'the dog with the bad name'", and that it was time for this attitude to be critically re-examined.

Need for Research on Spontaneous Cancer in Animals.—The subject of cancer in domesticated animals has not been studied so extensively as in man; a reminder of this is seen in Willis's book (1934), where in the section on the spread of animal tumours reference is mainly to those of laboratory animals. One reason for this neglect has been the lack of organized systematic routine autopsies of animals on a large scale; carcass inspection in slaughter-houses is not of much value as most animals killed for food are not of the cancer age. Nevertheless, records of animal cancer abound in veterinary literature, although many are of dubious value as the pathological descriptions are often inadequate and unillustrated. Unless meticulous autopsies with histological examinations are made on a large series of animals, many tumours, especially of the internal organs, may evade recognition or accurate diagnosis may be impossible. The bulk of animal records concern tumours of the skin, eyes, lips, mouth, breast, tongue, anus, etc., which only means they are more easily and clinically discernible; more attention has been paid to the dog than any other animal. Gliomata are regarded as rare in domestic animals, but until many thousands of brains have been examined we really do not know if this is so. The few records have referred simply to a "glioma" or a "gliosarcoma", and it is but recently that modern neurological nomenclature has been used, e.g., Jungherr and Wolf (1939). 'Hodgkin's disease' is referred to in veterinary text-books as an established entity in dogs, but there have been no authenticated cases reported; the disease seems to have been confused with leukæmia. A few of the neoplastic or neoplastic-like diseases which have not been identified clearly in domesticated animals might include meningioma, the gliomas, bronchial carcinoma, the reticulo-endothelioses, the 'lipoidoses' (Gaucher's and Niemann-Pick's diseases), Ewing's tumour, chordoma, glomangioma, adrenal neural tumours, and most of the subvarieties of sarcomata of bone; other tumours have been recorded with full data very rarely, e.g., gastric and rectal carcinoma. Their reputed non-occurrence or rarity may be more apparent than real, for many might be found if a more systematic search was made. On the other hand, several tumour peculiarities in animals are probably not well known to the medical oncologist, e.g., the benign and malignant forms of osteogenic breast tumours in dogs, the squamous-cell carcinoma of the horse's stomach (said to be associated with *Gastrophilus* larvæ), embryonal tumours (Wilms' tumours?) of pigs' kidneys, etc.

More data, therefore, are wanted regarding the types, location, and genesis of tumours in animals, the paths of dissemination of malignant tumours, and the survival periods of animals after surgical or any other treatment, for it is this type of information the medical worker might want if he turns to the animal aspect for help. For example, work on the spread of cancer of the human breast would have been amplified if comparative studies had been made with canine material, and much might have resulted from controlled clinical trials, with proper follow-ups, on the effect of treatment of animal cancer cases by X rays, irradiation, and surgery. Cancer research would benefit greatly if such research programmes were made, as many problems could obviously be better investigated by using both animal and human material than by the latter alone.

This would be particularly valuable in the case of follow-up studies after therapeutic or surgical treatment of spontaneous cancer in animals, for the simple reason that results would be achieved in a much shorter space of time. Information derived from such studies would have considerable importance from the point of view of comparative oncology, and animal work could be carried out as a controlled experiment for the checking up of results in the human being.

The above statements have been made before elsewhere, but their repetition perhaps emphasizes the need for more pathological work on spontaneous cancers in animals.

It was with these ideas in mind that work on animal tumours was begun some fifteen years ago.

Material was systematically collected from animal surgical cases sent in for pathological reporting, and from animal autopsies; and together with human tumours obtained from various sources for comparative pathological studies, this material forms now an indexed collection of sections and data relating to about a thousand animal and about fourteen hundred human cases.*

TABULAR SUMMARY OF POST-OPERATIVE SURVIVAL PERIODS

CASE NO.	DATE OF OPERATION	BREED	AGE AT TIME OF OPERATION	DIAGNOSIS	SURVIVAL PERIOD	POST-OPERATIVE HISTORY
			Yr.		Yr. Mth.	
5125.22	23.5.31	Irish terrier	8	Seminoma	2 6	Killed; no evidence of metastasis at P.M.
5126.22	17.7.30	Griffin	8	Seminoma	4 6	Died; no clinical evidence of metastasis; no P.M.
5127.22	26.5.30	Terrier	12	Seminoma	3 6	Killed because of old age; excellent health after operation for 3 years.
5128.22	18.6.32	West Highland terrier	3	Seminoma	7 –	Killed because of old age; no illness since operation; no P.M.
5143.22	10.8.36	Fox terrier	11	Seminoma	6 6	Died of old age; no P.M.
5144.22	16.12.36	Pekinese	2	Seminoma	3 –	Died, "paralysis"; no P.M.
5145.22	2.1.37	Irish terrier	13	Seminoma	– 2	History of cough for years; emaciated at time of operation; no P.M.
5139.22	10.5.36	West Highland terrier	10	Seminoma	3 4	Alive and well until tumour-like swelling in other testicle; no P.M.
5149.22	6.2.37	Rough-haired terrier	12	Seminoma	4 –	Alive and well.
79.41	29.6.37	Sealyham	8	Seminoma	5 6	Alive and well.
29.45	19.10.37	Pekinese	6	Seminoma	1 6	Alive and well until just before death, when killed because of obscure symptoms.
42.47	25.10.37	Spaniel	9	Seminoma	5 –	Killed; old age, no evidence of recurrence; no P.M.
8.47	12.11.38	Terrier	10	Seminoma	1 –	Died; chronic nephritis.
41.46	19.7.38	Mongrel	9	Sertoli-cell tumour	2 –	Died of old age.
5165.22	19.3.37	Spaniel	11	Sertoli-cell tumour	4 7	Killed; no evidence of spread; No P.M.
78.41	3.7.37	Cross retriever	13½	Sertoli-cell tumour	3 –	Alive and well.
40.43	6.11.37	Spaniel	7	Sertoli-cell tumour	2 –	Alive and well.
60.45	5.4.38	Rough-haired terrier	6	Sertoli-cell tumour	5 1	Alive and well.
5179.22	22.1.31	Terrier	13	Malignant interstitial-cell tumour	1 3	Killed; massive metastases in para-iliac and para-aortic nodes.
5182.22	7.10.30	Sealyham	7	Malignant interstitial-cell tumour	– 7	Killed; metastases in lumbar nodes and large growth in inguinal canal.

Testicular Tumours in Dogs—Pathology and Malignancy.—A paper—Innes (1942)—has been published dealing with the pathology of the material relating to testicular tumours; the seminoma, as in man, appeared to be the common tumour, but there appeared to be a far greater incidence of testicular cancer in dogs. In man it seems a relatively rare form of cancer; for example, Brines (1930) found records of about 700 cases in the literature, while Tanner (1922) recorded that only 50 cases were observed in 300,000 admissions at the Mayo Clinic and 65 in 100,000 admissions at the London Hospital. Several other interesting pathological points emerged from the studies of dog cases, in particular relating to the part played by the interstitial cells in tumours or tumour-like growths. In addition

* Work done at the Institute of Animal Pathology, Cambridge University.

15 cases of an apparently rare tumour in man were observed in dogs—namely, the Sertoli-cell tumour, tubular adenoma, or "adenoma tubulare testiculare ovarii" (Pick). (This tumour has now been observed in the human being in ectopic testes, in the ovaries of women showing menstrual disturbances, and in hermaphrodite males.) In the paper on testicular cancer in dogs brief consideration was given to the question of malignancy. This fuller note on malignancy is written in view of the controversy which apparently exists regarding the malignancy of testicular tumours in man and the value of radical operation as opposed to orchidectomy or irradiation as a form of treatment. It is hoped that the paper might be of interest to surgeons and urologists whose work takes them into this field, and might at least stimulate an interest in the animal aspect.

The statement of Schlotthauer et al. (1938) that dogs do not live long enough for tumours to mature and metastasize is a peculiar one, as cases of canine cancer of many different organs with widespread metastases are a common enough experience of the animal pathologist. The span of life of an animal is probably quite irrelevant, as the period taken by untreated malignant tumours to mature, metastasize, and kill is probably the same in man and animals—namely, a relatively short one.

Twenty of the surgical canine cases—Innes (1942)—had been treated by orchidectomy and were followed up, some for many years. In all the autopsy cases, many of which showed advanced tumour growth, a careful search was made for evidence of spread to the para-iliac and para-aortic lymph-nodes. This search included histological examination of these regional lymph-nodes and portions of the lungs. A tabular summary of the results is given on the preceding page.

In the case of the seminomata orchidectomy must have been deemed to produce a high rate of cure. It is impracticable to use a five-year period in dogs as indicative of cure because of the relatively short life of a dog, and many of the tumours had occurred in dogs which were already very old. Even so the serious prognostic outlook so often adopted by many for human cases is evidently not applicable to canine cases. Most of the animals survived for a period of at least two years, some for much longer, and in those which died and on which an autopsy was permitted there was no evidence of even early metastatic spread after a fairly long period of survival. The possibility of earlier treatment of canine cases being responsible for this low-grade malignancy does not arise, as most of the testicular tumours were as fully advanced (size of enlarged testis—*see* Harvey, Dawson, and Innes (1940) for illustration of cases) as human cases are when they usually appear before the surgeon. This suggestion that the seminoma in dogs is a relatively benign tumour is supported by results of the anatomical dissections of many cases coming to the post-mortem table and upon which an operation had not been performed. Many of these were late cases and showed advanced tumour growth (in some the testis was 4 to 10 times larger than normal); in all of these a careful search was made for evidence of spread to the regional lymph-nodes, etc. In only one seminoma case was a microscopic metastasis observed in a lumbar lymph-node.

Five cases of the tubular adenoma or Sertoli-cell tumour were also traced. The number is too small to draw any conclusion, but the fact that four out of five of the animals operated on were relatively old and are alive and well two years, or more, after castration rather confirms the impressions based on histological grounds that it is a benign variety of tumour.

The two dogs which died after a short post-operative life were both cases which were classified as malignant interstitial-cell tumours.

Conclusions.—The conclusions seem to be: (*a*) that the testicular carcinoma (seminoma) in dogs, which is identical pathologically with the human tumour, does not behave in the same malignant way; or (*b*) that the results are a corollary to the views recently expressed by Payne—namely, that the seminomata in man are not as malignant as hitherto believed.

REFERENCES

BRINES, O. (1930) *J. Lab. clin. Med.*, **15**, 464.
CAIRNS, H. W. B. (1926), *Lancet*, **1**, 845.
CHEVASSU, M. (1906), "Les Tumeurs du Testicule", *Thèse de Paris*.
DEW, H. R. (1925), *Malignant Disease of the Testicle*. London.
GORDON-TAYLOR, G., and TILL, A. S. (1938), *Brit. J. Urol.*, **10**, 1.
HARVEY, W. F., DAWSON, E. K., and INNES, J. R. M. (1940), *Debatable Tumours in Human and Animal Pathology*. Edinburgh.
HINMAN, F. (1933), *Surg. Gynec. Obstet.*, **56**, 450.
INNES, J. R. M. (1942), *J. Path. Bact.*, **54**, 484.
JUNGHERR, E., and WOLF, A. (1939), *Amer. J. Cancer*, **37**, 493.
MACKENZIE, A. W., and KATNER, M. (1939), *J. Urol.*, **41**, 592.
PAYNE, R. T. (1938), *Lancet*, **1**, 364.
SCHLOTTHAUER, C. F., MCDONALD, J. R., and BOLLMAN, J. L. (1938), *J. Urol.*, **42**, 539.
TANNER, C. O. (1922), *Surg. Gynec. Obstet.*, **35**, 565.
WALKER, K. M. (1935), *Lancet*, **2**, 1924.
WILLIS, R. A. (1934), *The Spread of Tumours in the Human Body*. London.

REPAIR OF RUPTURED POPLITEAL ARTERY, WITH NOTE ON HEPARIN THERAPY AFTER ARTERIAL SUTURE

By G. F. LANGLEY

HON. ASSISTANT SURGEON, EAST SUFFOLK AND IPSWICH HOSPITAL

Ligation of a popliteal artery is a relatively simple procedure but fraught with such danger of gangrene of the distal limb as to render conservative surgery justifiable in spite of obvious risk.

Heparin therapy following conservative suture has given opportunities of success and yet, itself, brings new hazards into the scene, especially in the presence of a granulating wound.

In the case now described arterial suture was considered justifiable in spite of the existence of a pulsating hæmatoma and potential infection, but difficulties were encountered following heparinization though eventual success was achieved.

CASE REPORT

Lance-corporal J. J. K., aged 26 years, was admitted under my care to the Ipswich Borough General Hospital on June 11, 1942. While on exercises he had been shot through the right popliteal region by a rifle bullet which had entered on the outer side, emerged near the adductor tubercle, and then ricochetted from a wall causing a small metal foreign body to be lodged three inches higher, near the adductor canal.

On admission the blood-pressure was 120/85 and his condition was good; a fairly brisk hæmorrhage had been controlled by a field dressing. An X-ray film revealed a small metal foreign body under the higher, ricochet, wound; there was no bony lesion.

First Operation.—This was performed under gas-oxygen-ether anæsthesia with a tourniquet in position for part of the procedure. After toilet of each wound it was found that there was a large rent in the popliteal vein but the nearby artery showed only a slight abrasion of its adventitia and was not spasmodically contracted. The vein was doubly ligated, sulphanilamide powder was insufflated, and a dry gauze pack was lightly inserted, over which the wounds were partly sutured. On removal of the tourniquet brisk hæmorrhage occurred from the smaller wound due to laceration of the internal saphenous vein, which was ligated; hæmostasis was then complete. A back splint was applied outside the dressings and the foot was elevated in bed.

On June 22 (11th day) the sutures were removed and some of the pack was easily withdrawn. Inadvertently, the patient was allowed out of bed in the evening and a very brisk hæmorrhage occurred after flexing his knee in a chair. A house surgeon in the ward controlled the hæmorrhage by tourniquet followed by tight pressure bandaging; the leg was then raised in a Thomas splint used as a cradle.

On July 4 (23rd day) the splint was removed; all wounds appeared to be healthy and no further hæmorrhage had occurred.

On July 8 (27th day) he was allowed to get up.

On July 11 (30th day) he complained of some aching pain in the calf, but no obvious abnormality was noted.

On July 12 (31st day) the aching persisted and inspection of the wounds revealed a large, pulsating swelling 4 in. wide by 5 in. long in the popliteal space; both scars were now healed but were stretched over the swelling. Slight pulsation was felt in the posterior tibial pulse but none in the anterior. The foot was cooler and rather blue, but the capillary return was fairly good. The brachial blood-pressure was now 152/80, but the pressure at the right ankle was judged to be 115/?. Oscillometry was difficult, but a reading of 4 mm. on the left and 2 mm. on the right foot was obtained, while the blood-pressure at the left ankle was 150/?. A systolic bruit was heard. Measurements at three specially marked points over the swelling were: (*a*) 13⅜ in.; (*b*) 13½ in.; (*c*) 13⅞ in.

It was obvious that a traumatic pulsating hæmatoma (? false aneurysm) had developed, but as it was felt unikely that a good endothelial lining was yet available for reparative procedure I decided to apply graduated pressure and strict rest.

By July 16 (35th day) the measurements at the marked points had increased to (*a*) 14¾ in., (*b*) 14 in., (*c*) 15⅛ in. In the early morning his foot had felt 'dead', but had gradually recovered though some cramp in the calf occurred. Sensation was normal to pin-prick and the posterior tibial pulse was doubtfully palpable. Operation seemed to be risky, and it was felt that delay might establish a better collateral circulation if ligation were inevitable.

For several days his condition remained stationary, though all was ready for immediate operation.

On July 21 (40th day) the aneurysm burst; the hæmorrhage could not be controlled by local pressure and only by digital compression and then by tourniquet was the situation saved.

Second Operation (40th day).—With the ample warning of the anxious weeks all equipment for arterial repair was handy. Tourniquets were applied above and below the popliteal region and under gas-oxygen anæsthesia the popliteal space was opened by a long internal-posterior incision avoiding the burst internal wound as far as possible. The adductor magnus foramen was stretched almost beyond recognition and a dish full of clots was removed from the popliteal space and lower part of Hunter's canal. A longitudinal split was seen in the posterior wall of the upper part of the popliteal artery, ¾ in. long; the adjacent vessel wall looked surprisingly healthy in contrast to the surrounding clot-infiltrated tissues. With very fine paraffined thread on arterial (Carrel) needles, two layers of continuous mattress sutures were inserted, the second drawing the adventitia over the former. Novocain was injected into the adventitia.

Release of the two tourniquets showed hæmostasis to be complete.

Sulphanilamide powder was liberally dusted over the wounds but not over the artery itself, a light gauze pack was applied, and the major part of the incision closed. Throughout the operation all instruments, gloves, packs, etc., had been freely immersed in 2 per cent sodium citrate solution. A light plaster

splint was moulded over the dressings and the limb elevated in bed.

The clotting time was immediately checked and heparin therapy was commenced as indicated in the accompanying table.

and not swollen; a definite posterior tibial pulse was felt, but the anterior pulse was doubtful.

Re-admission on Oct. 3 for changing of the plaster showed a satisfactory condition of the circulation in the foot; the area of anæsthesia was slightly less

DETAILS OF HEPARIN ADMINISTRATION

CHART OF HEPARIN THERAPY				CLOTTING TIME		APPROX. HOURLY DOSE	REMARKS
Date	*Time*	*Dosage*	*Method*	*Time*	*C.C.T.*		
					Min.		
July 21	—	—	—	12.00	2½	—	Before heparin
	14.15	7,500	Single	14.35	2½		
	14.40	7,500	Single	14.55	4	11,000 approx.	33,750 units in 200 min. without success. Batch discarded
	15.10	22,000	Drip	16.15	2½		
	16.45	7,500	Single	17.35	2½		
	20.30	5,000	Single	20.45	3		New batch
	20.50	6,000	Single	21.10	5¾	7,500	
	21.10	10,000	Drip	21.35	6	10,000	Drip 40 drops/min.
	21.45	5,000	Drip	21.55	11½	11,500	Target approx. but low
	22.10	5,000	Drip	22.20	19¾	13,500	Excessive heparin
July 22	00.30	10,000	Drip	00.30	30	7,500	Drip slowed
	—	—	Drip	04.35	9½	2,500	60 per cent drop in 3 hr.
	04.45	12,500	Drip	09.00	12	3,000	C.C.T. measured now before replenishing drip only
	09.30	12,500	Drip	13.00	15¾	3,000	
	13.15	10,000	Drip	16.15	12	2,500	
	16.30	12,500	Drip	20.15	10½	3,000	
	20.45	12,500	Drip	24.45	10½	3,000	
July 23	01.40	15,000	Drip	06.15	12	3,000	C.C.T. rising (? cause)
	06.45	12,500	Drip	10.45	28½	3,000	Heparin suspended
	—	—	Suspended	13.05	14	—	50 per cent drop in 140 min.
	13.30	12,500	Drip	14.25	20	3,000	Again tendency to rise
July 24	Drip continued on this basis. C.C.T. approx. 12 min.						Bruising of thigh
July 25	Drip continued on this basis. C.C.T. approx. 12 min.						
July 26	10.00	Heparin discontinued owing to capillary hæmorrhage.					

Notes: C.C.T., Capillary Clotting Time (Dale); venous clotting times, frequently taken but not recorded in this chart, were comparable.
Single, Denotes single intravenous injection of heparin solution.
Drip, Denotes administration in normal saline drip approx. 40 drops per minute during stable stage.
Later chart was a repetition of above and is not included.
On July 23, at 01.40, B.D.H. Heparin was commenced, and it seems probable that this was the explanation of the rise in the C.C.T., although the unit-rate was maintained as far as possible. This seems a more potent brand, but later stability was easily obtained, though with a slightly reduced rate of drip.

On July 24 (43rd day) it was observed that there was anæsthesia over the external popliteal nerve distribution and also a complete foot-drop. The plaster was well padded and it was not considered blameworthy. The foot was warm and the capillary circulation brisk. Bruising of the inner thigh appeared above the plaster and it was decided to reduce the heparin and the clotting time as this was causing anxiety. Corrective slings controlled the foot-drop. There was slight pyrexia but the general condition was fairly good.

By July 26 (45th day) the bruising of the thigh had extended to the groin and was becoming alarming. An inspection window over the wound indicated that there did not seem to be any hæmorrhage from the artery, but that a severe capillary hæmorrhage was occurring. The heparin was stopped as a faint posterior tibial pulse was now palpable.

On Aug. 18 (68th day) the plaster was removed and also the gauze pack. A few exuberant granulations around the exit wound had to be cauterized, but otherwise healing was good. A further light plaster with foot support was applied. It was thought that the foot-drop was due to a combination of ischæmia and bandage pressure and that recovery would result with rest.

On Sept. 12 (93rd day) he was discharged to a B.R.C.S. Convalescent Home. The foot was warm but the foot-drop persisted. The wounds were almost healed and galvanic stimulation was commenced. There was no response to faradic stimulation.

On Oct. 17 a slight response to faradism was obtained; galvanic stimulation showed no reaction of degeneration, though double the normal milliamperage was required to cause contraction. Mr. Bell Jones, Orthopædic Surgeon, kindly saw him and agreed that the nerve lesion was partly ischæmic in origin and that the prognosis was favourable. He was fitted with a toe-raising spring with which he walked normally. He was again transferred to a Convalescent Home on Dec. 31.

He attended my out-patient clinic at monthly intervals, and, on Jan. 28, 1943, the motor power was almost normal, but anæsthesia to pin-prick and light touch was present over the lower half of the antero-external surface of the shin, dorsum of the foot, and great toe. He was walking five miles a day with the aid of his spring, which was then discontinued.

On Feb. 25, 1943, only a small area of anæsthesia was present over the dorsum of the foot and great toe and the motor power was normal. He was seen by a Medical Board and temporarily graded category 'C'. On March 15 he wrote that he could "run with the best and walk many miles without undue fatigue", and that "I shall attain a much higher

grade in the Army at the termination of the physical training course ".

COMMENTARY UPON THE ADMINISTRATION OF HEPARIN

Matheson and Murray (1942) advise that the administration of heparin should commence from four to twenty hours after operation in order to avoid undue capillary hæmorrhage from the wound. In this case the initial batch of heparin was of old stock and had to be discarded after proving ineffective. Three preparations were used —liquemin-Roche, heparin B.D.H., and a solution prepared by the pharmacist, Mr. J. Stretton, of the East Suffolk and Ipswich Hospital. The strengths of the different solutions varied, but no difficulty was encountered by basing the dosage upon the standard Toronto units and disregarding the varying strengths per c.c. A slight difference in efficiency in the solutions was noted.

The aim of heparinization was to prolong the clotting time to about five times the normal level. Several articles on this subject mention the necessity of keeping the clotting time at 15 or 20 minutes, but do not indicate by which method the clotting time was estimated. Dr. J. J. Dubash, pathologist to the hospital, performed frequent checks by simultaneously estimating the venous clotting time and the capillary clotting time. The venous time was, of course, always longer—by Lee and White's method normal figures of 6 to 20 minutes are quoted—whereas the normal capillary clotting time by Dale's method is 1 to 2 minutes. The discrepancy is great and it is thus obvious that in the articles quoted the target of 15 minutes indicates the capillary clotting time, but this should be defined. The figures run nearly parallel in a given patient, so that the capillary method, being much less distressing to the patient, may be accepted, and it seems advisable to aim at a figure of five times the normal for the patient rather than accept an arbitrary level.

Initial heparinization was undertaken by the single dose technique in an attempt to estimate the requirements before commencing the drip.

In this case it seemed apparent that no effect was obtained from the first batch, which was discarded; 5000 units raised the time in 15 minutes by 20 per cent, and then a further 6000 units raised the clotting time to about 130 per cent above the normal in a further 20 minutes. A further 2500 units received by the drip raised the figure to 450 per cent over normal at 115 minutes from the commencement. Thus, to achieve the approximate target in 115 minutes about 13,500 units were required. It appeared that the effect of the initial dosage was waning at the end of an hour and the dosage rate was increased to 11,500 units and then 13,500 units per hour, but this proved excessive. Eventually a target level of 10 to 15 minutes was maintained with an hourly dosage of approximately 3000 units in the drip.

From experiments conducted by us it appears that the maximal effect of a single dose appears within the first hour and the effect rapidly declines. The initial dose is higher than the subsequent maintenance requirement. It thus seems probable that a single injection of 5000 units could be followed by an intravenous saline-heparin drip of about 3000 units per hour commencing just before the end of the first hour. Estimation of the clotting time at twenty-minute intervals during the first two hours would seem advisable in order to ensure early stability.

Murray and Janes (1942) suggest that a dose of 1500 units given intravenously every four hours might suffice for an average adult. Our findings point to this being inadequate owing to the rapid decline after the first hour. A slowly acting heparin, comparable to zinc-protamine-insulin, would be an inestimable boon if it were possible to prepare it. They suggest, from comparison with animal experiments, that the requirements for surgical patients lie between 15 and 20 units per kilo body-weight per hour. On this basis my patient would have required up to about 1500 units per hour, whereas it was found that a satisfactory level was only obtained by using double this dosage, and, further, by continuous administration.

During the first day after arterial suture it is advisable to maintain a long clotting time, but after this it seems safe to reduce the level, and, especially in the presence of potentially infected granulation tissue, a reduction seems advisable to avoid the complication herein encountered; the capillary hæmorrhage was not obvious until the third day, but it had probably been hidden by the plaster. The clotting time had been kept rather above the standard level, but it was felt that the importance of the artery warranted a certain risk of capillary hæmorrhage and it is notable that on the day preceding the obvious hæmorrhage the clotting time had reached 28½ and 20 minutes on separate occasions.

COMMENT ON WOUNDS OF THE POPLITEAL ARTERY

In the *History of the Great War* (*Medical Services*) it is stated that gangrene of the lower leg occurred after 34·7 per cent of wounds and after 26·6 per cent of cases of ligation, for other reasons, of the popliteal artery. Even the femoral artery lesions have a 14 per cent and 11 per cent better chance of escaping gangrene; the popliteal is notoriously the most dangerous of all the limb vessels in respect of the risk of gangrene.

Wounds in the neighbourhood of the popliteal artery cause increased risk of gangrene if the vessel has to be ligated owing to reflex vaso-constriction of the collateral circulation. Arteriectomy, peri-arterial sympathectomy around the wound, and novocain infiltration around the main branches have all been tried in such circumstances. Suire and Sautter (1940) reported two cases of

bullet wounds and one of a shell fragment wound of the popliteal artery treated by these methods, but in each case amputation was later required. They decided that arterial wounds should be treated within two hours to hope for success; after this time such wounds are as serious as a total crushing injury and amputation is almost inevitable.

Sir George Makins pointed out the advantage of simultaneous ligation of the accompanying vein in lessening the risk of gangrene.

Arterial hæmatoma or traumatic aneurysm may follow any arterial wound in which free escape of blood is prevented or the arterial wall is secondarily eroded. Makins stated that the change from arterial hæmatoma to false aneurysm may take a number of days or weeks to develop. Grey Turner (1934) states that he never met with a definite pulsating tumour that could be described as an aneurysm, although he treated a large number of arterial hæmatomata in the last war. Makins ascribed the tardy development of aneurysms to two reasons: (*a*) the sac, being small, may be overlooked, and (*b*) the scar tissue may be ruptured through the original wound before the endothelial lining is fully developed.

In the treatment of arterial wounds William Anderson, quoted by Grey Turner, advocated delay for four to six days in the absence of hæmorrhage when a distal pulse was present. Burrows (1942) has advocated delay and the application of graduated pressure over an arterial hæmatoma with a view to allowing development of an intimal lining if suture is considered. Most authors (Holman, 1942) are agreed that arterial suture in the past has been disappointing and especially so in the presence of a friable vessel and potential sepsis in the area.

Several interesting features are presented in the case here described :—

1. The original wound merely abraded the popliteal artery but caused complete division of the vein; there was then no nerve lesion. It is possible that the low-grade infection caused rupture of the middle and intimal coats, resulting in the sharp hæmorrhage on the 10th day. It is of interest to consider whether immediate exploration of the artery should have then been undertaken, but pressure dressings were effective and the distal pulse remained so that conservatism appeared justifiable.

2. The arterial hæmatoma probably commenced after the hæmorrhage on the 10th day, but caused no obvious symptoms until the complaint of aching pain on the 30th day and the pulsating swelling was noticed on the 31st day. Even at this stage the posterior tibial pulse was palpable and oscillometry showed a moderately good circulation. Acting on the belief that delay would enable a better collateral circulation to develop and that arterial suture was unlikely to be possible, the treatment was commenced as for an early non-traumatic aneurysm. Clinical examination excluded the possibility of an arteriovenous fistula. If it could have been foreseen that suture would have been possible one would not have delayed operation at this stage.

3. After the rupture of the hæmatoma the operation revealed a surprisingly healthy arterial wall in spite of the massive surrounding clots and probable local infection; no endothelial lining of the cavity was noted, but this might have been easily overlooked among the clots. The technical procedure of repair was straightforward with the assistance of dual tourniquets and having had all necessary equipment ready. The vein had already been tied, but it is not clear from the literature whether ligature of the vein after arterial suture is advisable or not. It would seem that, considering the enhanced prospect of successful suture with the assistance of heparin, ligation of the vein would not be indicated for fear of increasing the back pressure in the sutured artery. Novocain blockage of the adventitia was carried out in this case to prevent spasm of the collateral circulation, but no spasm was noted in the exposed artery before this infiltration, even when the sutures were inserted; presumably the sympathetic action was temporarily inhibited by the recent hæmorrhage from the vessel.

4. The heparin administration has already been described, but it is possible that a slightly high level of clotting time was established especially in the later stages to account for the capillary bleeding. Five days of heparinization proved effective, though it had been intended to keep this going for ten days if the bruising had not been so severe.

5. The result of the arterial suture was quite satisfactory at an early date, but the unfortunate external popliteal nerve paralysis caused great delay in recovery. This nerve lesion might have resulted from stretching or pressure by the clots or dressings or have followed ischæmia. Probably a combination of both factors occurred as it now seems unlikely that, with so satisfactory a recovery in the circulation, sufficiently prolonged ischæmia ensued to produce nerve palsy, though the ischæmic nerve would be unduly sensitive to pressure effects. Full motor and almost complete sensory function has, however, occurred.

Arteriography was considered on several occasions, but the presence of the nerve lesion made one chary of undertaking this additional hazard. Clinical examination suggests, however, that the sutured artery maintained a sufficient lumen for normal nutrition and fairly good pulsation in its terminal branches.

SUMMARY

1. A case of rifle bullet wound of the popliteal vein with delayed rupture of the popliteal artery has been described.

2. Suture of the popliteal artery after rupture of an arterial hæmatoma was successfully performed.

3. External popliteal nerve palsy developed as a secondary complication, but recovered.

4. Heparin administration probably contributed to the saving of the limb.

5. It is suggested that heparin should be administered in a continuous saline drip as it is unlikely to be effective by intermittent intravenous injection ; the accepted dosage of heparin may be too small, and it is necessary for repeated examinations of the clotting time to be made.

6. A brief review of the literature is included.

It is a pleasure to acknowledge the untiring help of Dr. J. J. Dubash, Pathologist, E.M.S., at the Ipswich Borough General Hospital, and also of the Resident Medical Officers, Drs. N. Perry and J. Abrahams, who took great interest in their care of the patient.

REFERENCES

MATHESON, N. M., and MURRAY, GORDON (1942), *Surgery of Modern Warfare*, 2nd. ed., **1**, 237. Edinburgh : Livingstone.

MURRAY, G. D. W., and JANES, J. M. (1940), *Brit. med. J.*, **2**, 6.

History of the Great War (*Medical Services*), **2**, 170 (quoted by Learmonth, J. R., in *Surgery of Modern Warfare*).

SUIRE, P., and SAUTTER, Y. (1940), *Pr. méd.*, **48**, 652.

TURNER, G. GREY (1934), *Modern Operative Surgery*, 2nd ed. London : Waverley.

BURROWS, HAROLD (1942), *Surgery of Modern Warfare*, 248. Edinburgh : Livingstone.

HOLMAN, E. (1942), *Surg. Gynec. Obstet.*, **75**, 183.

CYSTS OF THE EPIDIDYMIS, THE SO-CALLED SPERMATOCELE

BY CECIL P. G. WAKELEY, C.B., LONDON

CYSTS of the epididymis have been known and described for a very long time, yet it is only a century ago that Robert Liston first defined the condition which to-day is known as spermatocele. However, Liston considered the condition as an encysted hydrocele containing spermatozoa. The term ' spermatocele ' was first used in its modern sense by Gavasse (1860) in describing a case (" Un Point de l'Histoire du Spermatocèle ", in *Gaz. Hôp., Paris*).

It is quite true that Guérin in 1785 used the term in association with an inflammatory condition of the testicle quite unlike that now recognized as a spermatocele. His paper, " Observation sur une Spermatocèle très considérable précédée des Phénomènes extraordinaires et terminée d'une Manière peu commune ", is in the *Journal de Médecine militaire, Paris*.

When one considers the intricate development of the testis in man it is rather surprising that the condition is not more common. In the early embryo the genital gland lies in the abdomen, medial to the mesonephric system, and the long axes of both are vertical. On reaching the false pelvis at the commencement of the third month their long axes are oblique or even horizontal. In the adult, the testes lie in front, the vas deferens and spermatic vessels are behind, while the digital fossa, which corresponds to the hollow between the tubal mesentery and the genital gland, is on the outer side (*Fig.* 140).

Up to the seventh week of intra-uterine life the genital gland does not possess any differentiating features.

AETIOLOGY

The aetiology of these cysts has led to much speculation in the past. There can be little doubt that by far the greater majority arise in that bridge of tissue between the testicle and epididymis, namely, the vasa efferentia.

Two factors alone seem to play any real part in the aetiology of these cysts, namely, trauma and infection. Both these agents are hard to assess because it must be admitted that most men during their lifetime suffer from some sort of trauma to their testicles. It is quite conceivable that slight local trauma may rupture some of the fine seminiferous tubules and so initiate a cyst. Venereal disease, in my experience, cannot be said to be a factor, but non-venereal infection of the epididymis is quite often a cause, and the commonest causative organism is the *Bacillus coli*.

From a purely anatomical point of view cysts of the epididymis may be extravaginal or intravaginal. The former are more frequent and usually arise behind the testicle, between it and the epididymis, and develop outside the tunica vaginalis. Such extravaginal cysts displace the testicle downwards and forwards and, as a rule, they are single.

The intravaginal cysts occur within the tunica vaginalis. Such cysts may develop to the size of a chestnut and, being situated just above the testicle, lead to the false impression on the part of the patient that he has a third testicle. Should such an intravaginal cyst burst into the tunica vaginalis a hydrocele will form, and possibly this process may be one cause of hydrocele formation.

All cysts of the epididymis are probably due either to a dilatation of one or more of the vasa efferentia testis (*Fig.* 141), hence the cyst may be unilocular or bilocular, or are caused by a distension of some of the fœtal relics always found near the head of the epididymis, especially those known as the organ of Giraldès (*Fig.* 141). Smaller pedunculated cysts, containing clear serum but

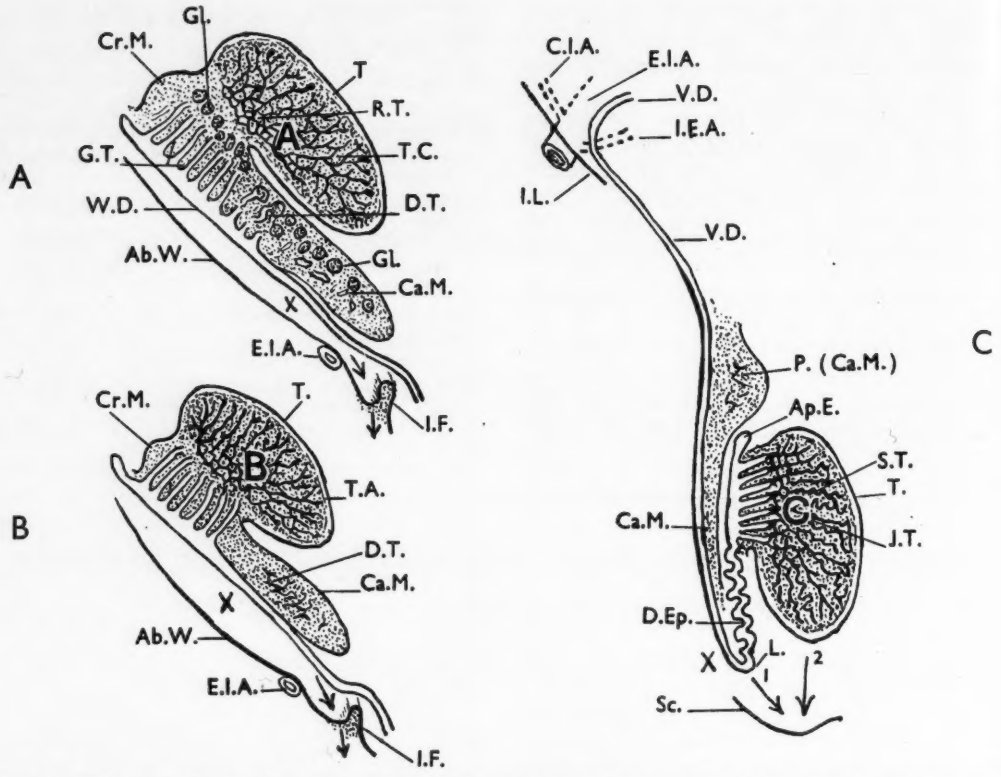


FIG. 140.—Diagram indicating the position of the testis and mesonephric structures during their descent from the false pelvis into the scrotum. A, 5th to 6th week; B, Middle of 3rd month; C, Final stage.

Ab.W., Abdominal wall; Ap.E., Appendix epididymis; C.I.A., Deep circumflex iliac artery; Ca.M., Caudal part of mesonephros (degenerates); Cr.M., Cranial part of mesonephros (degenerates); D.Ep., Coiled duct of epididymis; E.I.A., External iliac artery; Gl., Glomeruli; G.T., Genital tubules of mesonephros, which persist as the vasa efferentia and coni vasculosi, of the epididymis; I.E.A., Inferior epigastric artery; I.F., Inguinal fold, which contains fibres of the gubernaculum testis; I.L., Inguinal ligament (Poupart); J.T., Junctional tubules; L., Loop formed by traction of gubernaculum testis; M., Mesonephros; P., Paradidymis (organ of Giraldès); R.T. Rete testis; Sc., Floor of scrotum; S.T., Seminiferous tubules; T., Testis; T.A., Tunica albuginea; V.D., Vas deferens; W.D., Wolffian duct.

The arrows indicate the direction of descent.

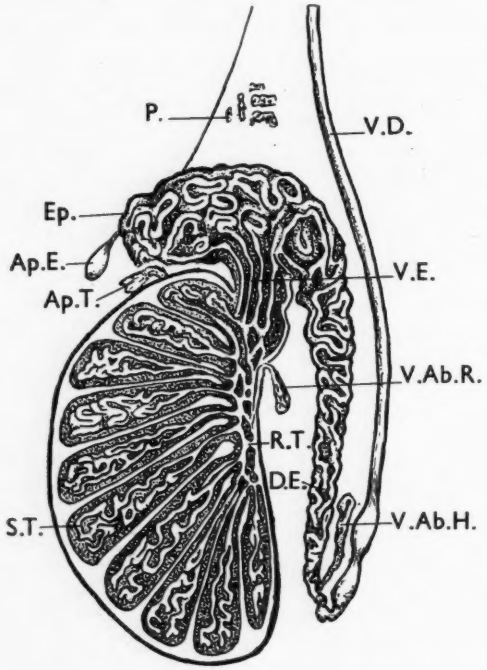


FIG. 141.—Diagram of adult testis to show relation of vestigial remnants.

Ap.E., Appendix epididymis (vesicular or stalked appendage)—vestige of cranial end of mesonephros; Ap.T., Appendix testis (fimbriated or sessile appendage); D.E., Duct of epididymis; Ep., Head of epididymis; P., Paradidymis (organ of Giraldès)—vestige of caudal part of mesonephros; R.T., Rete testis; S.T., Semmiferous tubules; V.Ab.H., Vas aberrans of Haller; V.Ab.R., Vas aberrans of rete testis; V.D., Vas deferens, derived from mesonephric duct; V.E., Vasa efferentia.

no spermatozoa, are sometimes met with at the upper part of the epididymis; these are due to the distension of the appendix testis.

CLINICAL MANIFESTATIONS

My interest in cysts of the epididymis began when as house surgeon to Mr. Burghard a case of torsion of the testis was operated upon and the testis removed. A small cyst at the upper border of the epididymis was found to contain a few spermatozoa. During the last twenty-five years some 34 cases of epididymal cysts have come under my care, 22 of which contained spermatozoa.

The usual type of spermatocele is a retention cyst of the epididymis found at the upper pole of

that organ. It is usually single and varies in size from a cherry to an orange. From the developmental standpoint, multilocular and bilocular spermatoceles should be more common than they are. No doubt small spermatoceles never come under clinical observation as they give rise to no symptoms and are often missed by pathologists in complete post-mortem examinations.

The actual swelling is cystic, translucent, and is often thought by the patient to be a third testicle owing to its position. Translucency is always present, but it varies in degree in different cases. The fluid may be almost clear in some, while it is opalescent in others. In my opinion, the degree of opalescence has nothing to do with the number of spermatozoa which are found in the fluid; a very opalescent fluid may contain few. As a rule, the specific gravity of the fluid is lower than that of ordinary hydrocele fluid, and there is little albumin.

Table I.—Analysis of 22 Cases of Spermatocele

No.	Age	Position of Swelling	Size of Swelling	Duration	History of Trauma	Pathology	Treatment
1	42	Right side	Billiard ball	3 yr.	None	Milky fluid containing live spermatozoa	Excision of cyst
2	28	Bilateral	Right side, orange; left side, large plum	4 yr.	None	Opalescent fluid containing live spermatozoa	Excision of both cysts
3	31	Left side	Large plum	3 yr.	None	Opalescent fluid containing live spermatozoa	Excision of cyst
4	42	Left side	Trilocular swelling	10 yr.	None	Milky fluid, Sp. Gr., 1006. Live spermatozoa	Left orchidectomy (*Fig.* 142)
5	25	Right side	Cricket ball	5 yr.	Kicked at football, age of 16	Opalescent fluid containing live spermatozoa	Excision of cyst
6	29	Right side	Large plum	2 yr.	None	Opalescent fluid, Sp. Gr. 1008. Live spermatozoa	Excision of cyst
7	18	Left side	Billiard ball	3 yr.	None	Opalescent fluid, Sp. Gr. 1006. Live spermatozoa	Excision of cyst
8	22	Right side	Large plum	2½ yr.	None	Opalescent fluid. Live spermatozoa	Excision of cyst
9	28	Right side	Billiard ball	2 yr.	None	Opalescent fluid. Live spermatozoa	Excision of cyst
10	47	Right side	Trilocular swelling	10 yr.	None	Spermatozoa present in all three cysts	Excision of cysts (*Fig.* 143)
11	31	Right side	Billiard ball	5 yr.	None	Spermatozoa present, mostly dead	Excision of cyst
12	76	Right side	Cricket ball	2 w.	None	Three cysts containing spermatozoa	Orchidectomy (*Figs.* 144, 145)
13	32	Left side	Large plum	2 yr.	Left testicle injured at cricket 6 years before	Opalescent fluid. Sp. Gr. 1006. Spermatozoa	Excision of cyst
14	25	Right side	Large plum	3½ yr.	None	Opalescent fluid. Sp. Gr. 1008. Spermatozoa	Excision of cyst
15	55	Right side	Bilocular	1 yr.	None	Opalescent fluid. Spermatozoa present	Orchidectomy (*Fig.* 146)
16	41	Right side	Large plum	5 yr.	None	Opalescent fluid. Sp. Gr. 1006. Spermatozoa present	Excision of cyst
17	36	Left side	Billiard ball	3 yr.	None	Opalescent fluid. Sp. Gr. 1006. Spermatozoa present	Excision of cyst
18	45	Right side	Multilocular	7 yr.	None	Multiple thin-walled cysts containing spermatozoa	Orchidectomy (*Fig.* 147)
19	43	Right side	Lemon	5 yr.	None	Milky fluid. Spermatozoa present	Excision of cyst (*Fig.* 148)
20	32	Left side	Large plum	2 yr.	None	Milky fluid. Sp. Gr. 1006. Spermatozoa present	Excision of cyst
21	68	Right side	Cricket ball	3 yr.	None	Milky fluid, Spermatozoa present	Right orchidectomy (*Fig.* 149)
22	14	Right side	Cherry	4 yr.	None	Milky fluid. Spermatozoa present	Excision of cyst (*Fig.* 150)

If the fluid is allowed to stand, two definite layers separate out, a clear one above and a whitish one below. On microscopical examination of the whitish sediment many lymphocytes are seen, together with fat globules, epithelial cells, and spermatozoa. The spermatozoa will be active if the cyst is in communication with the seminiferous tubules, but dead if no such communication exists.

CASE REPORTS

Table I is an analysis of 22 cases of cysts of the epididymis, all of which contained spermatozoa.

A detailed description of 8 cases is now given as they are of definite clinical interest.

Case 4.—John H., aged 42, married, had noticed a swelling of his left testicle for some ten years. There was no history of trauma, although the testicle was compressed at times when he rode his bicycle. The patient had led a very active life as a farm-hand, and had never had a day's illness since he was 15 years of age. His wife had borne him five children—3 boys and 2 girls. For two years prior to admission to

FIG. 142.—Specimen of trilocular spermatocele removed from *Case* 4.

hospital the left testicle had become painful and the swelling of the organ much more marked.

ON EXAMINATION.—The left testicle was much larger than the right one, and three distinct swellings could be palpated. All appeared to be attached to the testicle. The uppermost swelling was quite translucent, but the lower ones were not. The testicle felt heavy, but there was a well-marked testicular sensation. The Wassermann reaction was negative.

OPERATION (May, 1919).—The testicle was exposed through the left inguinal incision, and the gland was drawn up into the wound. The testicle felt hard and three well-defined cysts were seen attached to its anterior surface. It was thought that the condition of the testicle might be malignant so an orchidectomy was performed. The patient made an uninterrupted recovery. The cysts were aspirated, and all three contained milky fluid, specific gravity 1006, no albumin, and many spermatozoa. The lowermost cyst contained some cholesterin crystals.

The specimen was hardened; and when fixed was cut through. The testicle appeared normal on macro- and microscopical examination. The epididymis shows multilocular cysts distending it, all of which contained milky fluid (*Fig.* 142).

Case 10.—William T., a married man aged 47, first noticed a small swelling in the right side of his scrotum some ten years prior to operation. The

FIG. 143.—Specimen of trilocular spermatocele removed from *Case* 10.

swelling was first tapped in 1921, and the fluid was milky in consistency and contained numerous spermatozoa, some of which had no tails. The swelling was translucent and was quite painless, and inconvenienced the patient only when he played cricket.

ON EXAMINATION.—The swelling was composed of three lobules on the right side of the scrotum above the testicle in front of the lower portion of the spermatic cord, and well below Poupart's ligament. The swelling was fluctuant, but gave no impulse on coughing.

AT OPERATION.—The cysts were excised through a small inguinal incision, and the patient made a rapid recovery. The cysts all contained spermatozoa, and the walls were very thin and transparent (*Fig.* 143).

Case 12.—George B., a married man aged 76, came up to hospital complaining of a lump in his right testicle for two weeks. He was a healthy man for his age and he had not lost weight.

ON EXAMINATION.—The right testicle was swollen to about three times the size of the left. A translucent swelling could be detected above the enlarged testicle. The cord was not thickened. The testicle was hard and heavy and a diagnosis of malignant disease of the testicle was made, and orchidectomy advised.

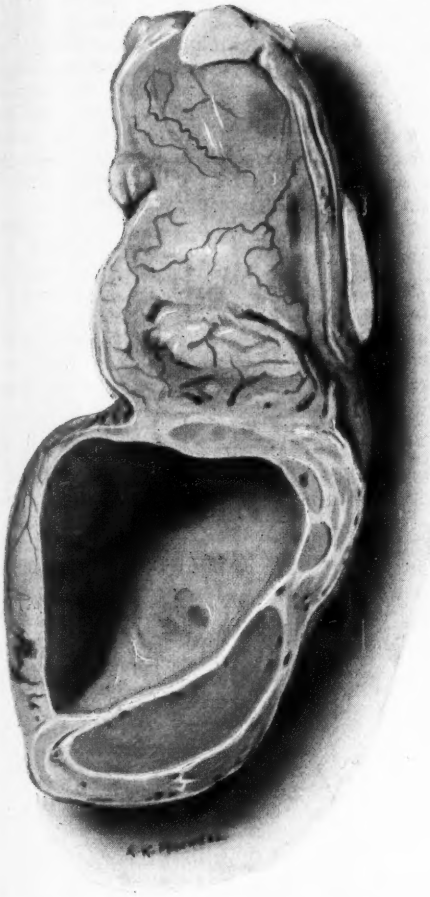


FIG. 144.—Specimen of large spermatocele removed from a patient aged 76 (*Case* 12).

OPERATION was performed and the testicle removed through a scrotal incision. Recovery was uneventful.

THE SPECIMEN.—This measured 2½ in × 3 in., with 3½ in. of the cord. On section (*Fig.* 144) the enlargement was found to be due to an oval cyst 2½ in × 2 in., and the compressed testis occupied the posterior wall. The lining of the cyst was smooth and contained thick mucoid material. Two small cysts are present in the upper pole of the epididymis.

Microscopically, the wall of the large cyst is formed of dense fibrous tissue (*Fig.* 145), with an intense chronic inflammatory infiltration. No trace of an epithelial lining remains, but the small cysts are lined by columnar epithelium. The testis is somewhat fibrotic, but there is well-marked spermatogenesis. The epididymis is fibrotic, and shows dense inflammatory epididymitis involving a pre-existing spermatocele.

Case 15.—Henry J., a married man aged 55, complained of a painless swelling in the right side of his scrotum, which was first noticed twelve months previously. It had increased slowly, but steadily, in size. The patient, a nervous and somewhat depressed individual, was not able to follow his employment, owing to the fact that his thoughts were concentrated on his enlarged testicle.

ON EXAMINATION.—A swelling the size of two testicles was present in front and above the gland on the right side. It was fluctuant, translucent, and apparently bilocular. Owing to the depressed condition of the patient, and his constant desire to have his testicle removed, an orchidectomy was performed. The patient made an excellent recovery, and was quite a different man. He returned to his work three weeks after leaving hospital.

THE SPECIMEN (*Fig.* 146).—A right testicle with adjacent portion of the spermatic cord. The head of the epididymis is represented by two communicating thin-walled cysts. The vas crosses the wall of the

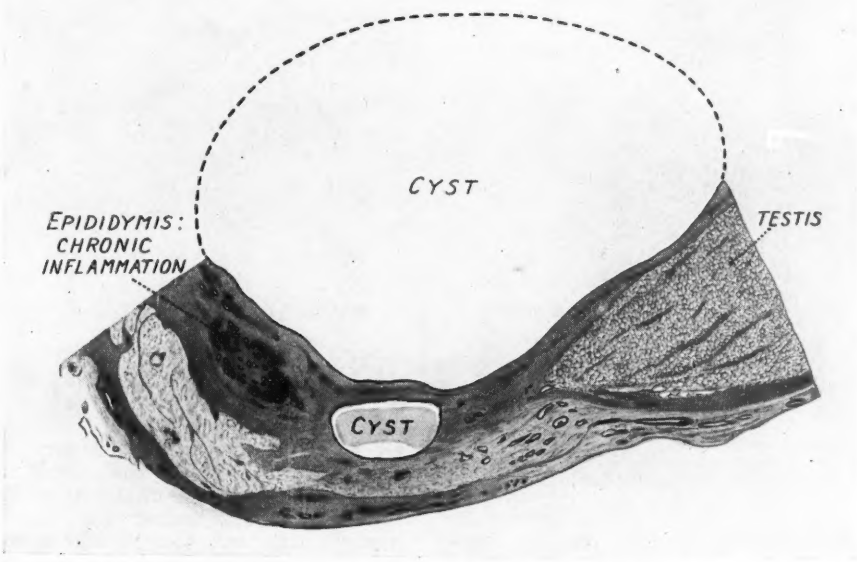


FIG. 145.—Microscopical section of wall of spermatocele (*Case* 12).

larger cyst to reach the lower pole. When opened the cysts contained a slightly turbid fluid containing spermatozoa.

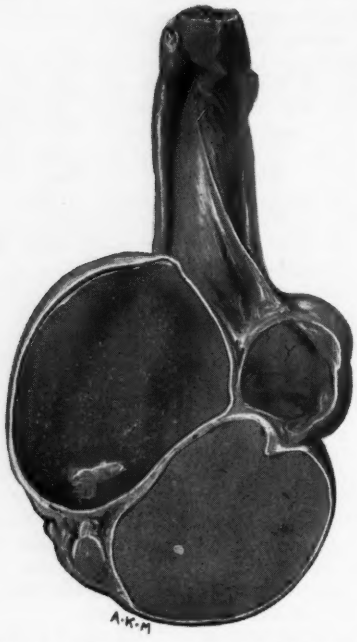


FIG. 146.—Bilocular spermatocele removed from *Case* 15.

Case 18.—George T., aged 45, a clerk, came under observation in 1936, because of a large recurrent right inguinal hernia. He also complained of some swelling

FIG. 147.—Multilocular spermatocele removed from *Case* 18.

and intermittent pain of his right testicle. Seven years previously, he had been operated upon in Wales for a right inguinal hernia. The hernia recurred six months after the operation, and gradually became bigger and bigger. When seen in 1936, there was a large right scrotal hernia, and an enlarged right testicle. The hernia could not be reduced, and the testicle could only be palpated with difficulty. It was decided to operate on the hernia and remove the testicle, so that complete closure of the inguinal canal could be obtained. This operation was performed to the complete satisfaction of the patient, who was examined two years after the operation, and found to be in good health. The hernial scar was sound, and there was no sign of weakness.

The specimen (*Fig.* 147) shows the right testicle with the adjacent portion of the spermatic cord. Occupying the position of the epididymis, there is a mass of thin-walled cysts varying in size up to 1 in. in diameter.

Histologically, the thin-walled cysts are lined by flattened epithelium; spermatozoa were found in the cysts. The testis appeared normal, and showed active spermatogenesis.

Case 19.—William H., a postman aged 43, first noticed a swelling of his right testicle five years before he came under observation in 1938. The swelling gradually became larger, and as it interfered with his riding his bicycle he was advised to have it removed. When seen in 1938 the swelling was about the size of a lemon, and was attached to the upper pole of the right testicle. The swelling was translucent and

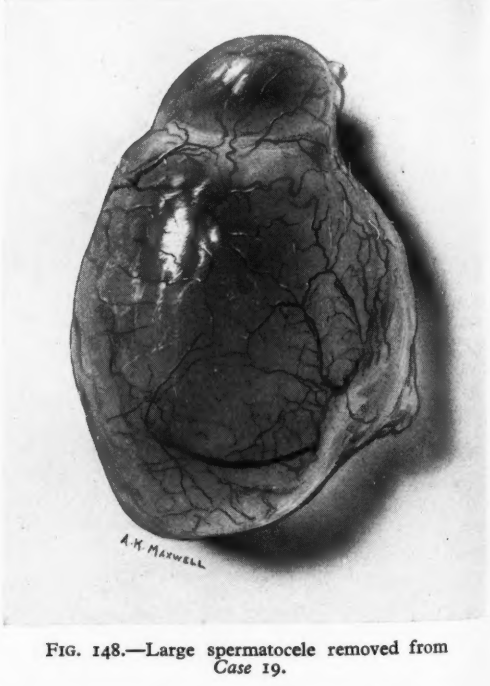


FIG. 148.—Large spermatocele removed from *Case* 19.

cystic. It was dull on percussion and there was no impulse on coughing. The vas deferens was not thickened, and the testicle itself was not painful. Operation was performed on June 22. The cystic swelling was removed through a scrotal incision. The spermatocele was dissected off the upper pole of the testicle. The wound healed per primam. The contents of the spermatocele were milky in appearance. Numerous spermatozoa could be seen under the microscope.

The specimen consists of an oval cyst 3 in. × 2 in., with a thin translucent fibrous tissue wall (*Fig.* 148).

Case 21.—George H., aged 68, had suffered from a right inguinal hernia for over twenty years, and for the last five years this could not be controlled by a truss. In 1934 a swelling above the right testicle

FIG. 149.—Trilocular spermatocele removed from *Case* 21.

was noticed; this was tapped, a whitish fluid containing spermatozoa being withdrawn. In 1938 this swelling was about the size of a cricket ball, and it was tapped again. Six months later, after an attack of subacute intestinal obstruction, due to his irreducible right inguinal hernia, it was decided to operate.

A radical cure was performed, together with a right orchidectomy, in order that the inguinal canal might be closed completely. The patient made an uninterrupted recovery.

The specimen (*Fig.* 149) shows a trilocular spermatocele in association with the testicle. The testicle itself contained a small cyst.

Case 22.—Eric P., aged 14, came under observation in December, 1936, complaining of a swelling of the right testicle. The swelling for the most part was above the testicle and was cystic and slightly translucent. It was tapped and found to contain opalescent fluid containing immature spermatozoa. The boy became very worried about the swelling, and his father wished it to be removed.

On Jan. 3, 1939, an excision of the cyst was performed, leaving the testicle intact. The cyst itself had an upward prolongation towards the external abdominal ring (*Fig.* 150). The boy made an uninterrupted recovery.

FIG. 150.—Small unilocular spermatocele with upward prolongation.

TREATMENT

There can be no doubt that the correct treatment of a cyst of the epididymis which is large enough to cause symptoms is complete excision. Injections of sclerosing fluids may prove successful in a few cases, but on the other hand they may convert a simple unilocular cyst into a very adherent multilocular one.

There is also the psychological aspect of these cases to be considered; patients are inclined to be more worried about a swelling in the region of their genitalia than one elsewhere in the body, and a complete excision of the sac will often put an end to months of anxiety and mental strain.

These cysts can be excised through an incision in the upper part of the scrotum; in my opinion, there is no reason to make an incision over the inguinal region and force the testicle up and out of the scrotum. Direct access is an important axiom in surgery, and the skin of the scrotum can be sterilized perfectly well prior to operation and heals by primary union. I always operate on hydroceles through the scrotal integument, and see no valid reason why this direct form of approach should be condemned and an indirect approach through an inguinal incision used.

When the cyst is exposed it should be carefully excised from the upper part of the epididymis. Complete excision is practically always possible and should be attempted as incomplete excision leads to a recurrence.

In those cases where the cyst is punctured and doubt exists as to whether complete excision has been performed, the area of attachment to the epididymis should be cauterized with a diathermy point. Absolute hæmostasis is essential to prevent a collection of blood in the loose, lax, scrotal integument.

CRITICAL REVIEW

INGUINAL HERNIA

By Brigadier HAROLD EDWARDS
CONSULTANT SURGEON, SOUTHERN COMMAND, HOME FORCES

"History", said Henry Ford, "is bunk". The opinion of the manufacturing magnate cannot be turned down out of hand. If his remark was a purposive overstatement intended to free the mind of the moderns from the fetters of tradition and to encourage in it free play unhampered by the fear occasioned from errors of the past, then his view is to be approved. None the less, study of the factual history of an enterprise or a crusade can be a very salutary experience. The story of man's struggles with hernia is an outstanding example, and a study of it is commended to all those who in the immediate past have deceived themselves, or in the future intend to deceive themselves, into designing and perfecting and offering to the surgical world a new operation for the radical cure of this age-old deformity.

For there is little doubt as to its antiquity. It is equal to that of man himself, and attempts at cure are at least as old as is caligraphy. In the first century A.D., five hundred years after Hippocrates had described treatment by plasters, the famous Roman surgeon Celsus practised ligature and excision of the unopened sac, combined with removal of the corresponding testis. A century later Heliodorus practised freeing the sac from the cord and removing it after twisting and tying it off. To this procedure, Oribasius added treatment of the inguinal region by cautery in the fourth century A.D., in an effort to supplement the normal support of the parietes by encouraging the development of fibrous tissues, as did Paulus Aeginata three hundred years afterwards. Ambrose Paré slipped a ligature round the neck of the sac, and tied it over a bone plate, aiming at obliterating the sac by sloughing, and two hundred years later De Garengeot dissected the sac, folded it into a pad, and left it to block the inguinal canal.

The mortality from these operations in those dark days, and the suffering their performance caused, led to a reaction against the employment of surgery for hernia in the early part of the nineteenth century, though Langenbeck persevered. Towards the middle of the century, Pancoastin recommended injection of iodine into the sac (the forerunner of injection therapy), whereas Velpeau opened the sac and applied iodine direct, thus anticipating the combination of surgery and sclerosing therapy described in the *British Medical Journal* a few years ago. Bonnet relied on the creation of sepsis; and the seton treatment, designed to produce obliteration of the sac by peritonitis, was popular in the middle of the last century. Wood's method of subcutaneous ligature of the sac was published in 1863.

The emancipation of surgery by Lister between the years 1870 and 1890, as for all surgical problems, introduced a new era, and put an end to most, if not all (*vide* injection) of the blind and uncertain methods of the past. The inguinal canal could now be exposed with safety and dissected at leisure. It became possible to think in terms not only of ligature and excision of the sac, but also of plastic operation designed to strengthen the posterior wall of the inguinal canal. In 1889 Bassini published details of his famous operation, and in the same year Halsted described his, which differed only in detail. This was an advance in breadth and depth greater than anything that had been achieved in the history of surgery for hernia throughout the centuries.

The Hernia Calendar

900 B.C.		Treatment by girdle and compresses by the Phœnicians.
400 B.C.		The writings of Hippocrates.
1st century A.D.		Celsus. Ligature and excision of the unopened sac.
2nd century A.D.		Heliodorus. Ligature and excision of the freed sac.
4th century A.D.		Oribasius. Ligature and excision of the freed sac followed by cautery.
7th century A.D.		Aeginata. Ligature and excision of the freed sac.
(The Dark Ages.)		
16th century A.D.		Paré. Obliteration of sac by tension ligature and sloughing.
16th century A.D.		De Garengeot. Dissection of sac, rolling into pad and suturing into inguinal canal.
1836.	Bonnet	Cure by sepsis.
1840.	Wutzer.	Seton treatment.
1844.	Pancoastin.	Injection of iodine.
1851.	Velpeau.	Exposure and opening of sac and application of iodine.
1857.	Wood.	Subcutaneous operation for ligature of sac (Lister).
1881.	Marey.	High ligature of sac and transplantation of cord and reconstruction of canal.
1886.	MacEwan.	Plugged internal ring with rolled up sac.
1889.	Bassini.	High excision of sac and posterior repair (development of Marey's operation).
1889.	Halsted.	Use of cremaster fascia and overlap of external oblique.

1895.	Andrews.	Channel for cord made in external oblique aponeurosis
1897.	Fowler.	Dissection of deep epigastric and intraperitoneal transplantation of cord.
1898.	Brenner.	Use of cremaster to reinforce canal.
1898.	Bloodgood.	Transplant of rectus muscle and sheath.
1899.	Fergusson.	Suture of internal oblique and conjoined tendon over the cord.
1904.	McArthur.	Fascial suture obtained from external oblique aponeurosis.
1905.	Scott.	Relaxation incision in rectus sheath.
1906.	Torek.	Dissection of cord and separation of vas from vessels.
1908.	Edmunds.	Abdominal approach for bilateral hernia.
1909.	McGavin.	Filigree operation.
1910.	Kirschner.	Fascial transplant from thigh.
1911.	Downes.	Rectus muscle to Poupart's ligament.
1913.	Hull.	Ligation of sac with minimum disturbance.
1913.	Bates.	Small incision. Peritoneum opened at internal ring.
1916.	Watson.	High transplant of cord.
1919.	La Roque.	Transperitoneal ligature of sac.
1921.	Gallie.	Repair by living sutures.

Since the publication of Bassini's operation over fifty years ago, innumerable modifications, and 'new' operations, have been devised and published by their originators. They are too numerous all to be mentioned; and only the more widely known are described and that but briefly. It is doubtful whether many of them have turned out to be an improvement upon the method Bassini first described. The only outstanding contribution has been made, in fact, by Gallie and Le Mesurier in their adoption, and publication in 1921, of the use of fascial sutures —a development of the work of Kirschner (1910).

EPONYMOUS OPERATIONS—A SELECTION

In all, the sac is dissected high up, ligatured after transfixion, and excised.

1. Andrews (1895).—Cord lifted free, and internal oblique and conjoined tendon sutured to Poupart. External oblique overlapped, and cord laid in narrow bed thus formed—the upper flap of the aponeurosis is sewn to Poupart's ligament behind the cord, and the lower flap is brought up over the cord, and sutured to the aponeurosis.

2. Bassini (1889).—Suture of internal oblique and conjoined tendon to shelving edge of Poupart's ligament to form the floor of the inguinal canal.

3. Bates (1913).—Through a 2-in. incision the aponeurosis of the external oblique is opened to expose the internal ring. The sac is defined and the peritoneum opened at its neck. The internal ring and transversalis fascia are pulled up into the wound and closed by a purse-string suture (leaving room for the cord to emerge), which is continued to repair the peritoneum.

4. Bloodgood (1898).—In this operation, designed for the radical cure of both direct and indirect hernias, a portion of the rectus sheath and muscle are transplanted to reinforce the posterior wall of the inguinal canal. The anterior rectus sheath is incised for a distance of 2 in. and the rectus muscle and sheath drawn down and sutured with the internal oblique and conjoined tendon to the shelving edge of Poupart's ligament. A modern modification is to turn down a triangular flap of the rectus, and suture that to Poupart's ligament.

5. Brenner (1898).—As Bassini, but using the cremaster muscle to reinforce the internal oblique and conjoined tendon in reconstructing the floor of the inguinal canal.

6. Downes (1911). (For direct hernia.)—The sac is excised and the transversalis fascia repaired. The transversalis and internal oblique muscles are dissected free down to the rectus sheath, which is opened so that the rectus muscle is exposed down to the pubis. The edge of the rectus is now united to the shelving edge of Poupart's ligament, and then the internal oblique similarly sutured (under the cord). Finally, the internal oblique flaps are overlapped.

7. Fergusson (1899).—The external oblique aponeurosis is separated from the internal oblique outward as far as a point opposite the anterior superior spine. The internal ring is narrowed by catgut sutures without disturbing the cord, and the edges of the external oblique are overlapped.

8. Fowler (1897).—Following normal exposure, and ligation of the sac, the deep epigastric artery is divided between ligatures. The peritoneum in the floor of the canal is divided, and the cord placed in the peritoneal cavity, emerging at the lower end of the peritoneal incision, which is closed. The inguinal canal is then completely closed, except at its lower end, through which the cord passes.

9. Gallie (1921).—Fascial suture. Repair of the posterior wall of the inguinal canal by interlacing strands of fascia lata between the conjoined tendon and Poupart's ligament.

10. Halsted (1889, but later modified).—Sutures passed through internal oblique and conjoined tendon to pick up cremaster muscle and fascia, and then returned through internal oblique and conjoined tendon, so that cremaster muscle and fascia is drawn up under the internal oblique and conjoined tendon. The cord is not disturbed. The internal oblique and conjoined tendon are sutured to the shelving edge of Poupart's ligament (over the cord). The flaps of the external oblique aponeurosis are overlapped, the edge of the upper flap stitched to the outer surface of the conjoined tendon and internal oblique, the lower flap brought down and sewn to the outer flap.

11. Hull (1913).—This method is designed to cause as little disturbance as possible, and is, according to its originator, suitable for 90 per cent of inguinal hernias. Through a ½-in. incision in the skin, the external oblique aponeurosis is opened for ½ in. mesial to the internal ring, the cremaster fibres separated, and the sac defined, pulled up into the wound, cleared over a small area, and divided. The neck of the sac is separated as high as possible, ligated by transfixion, redundancy excised, and the stump allowed to retract into the abdomen. The incision in the aponeurosis and skin are closed with one stitch.

12. Kirschner (1910).—A free graft of fascia lata, 2–3 in. wide and longer than the area to be covered, is sewn over the suture line of the external oblique.

13. La Roque (1919).—The fibres of the internal oblique and transversalis are separated an inch above their lower margins, and the peritoneum opened above the neck of the sac (if the muscles are thin retraction is sufficient to expose peritoneum). The sac, emptied of contents, is freed, dissection being aided by putting a finger into it from the peritoneal opening. Forceps are inserted into the sac, and the lowest portion grasped and inverted into the abdominal cavity. Sutures are passed through the peritoneum 1 in. above the internal ring, and the sac removed, so that the peritoneal aspect of the internal ring is completely obliterated. The incision in the muscles is repaired and the canal closed, with or without transplantation of the cord.

14. McArthur (1904).—This differs from the Bassini method only in that two strips of fascia cut from the upper and lower flaps of the external oblique aponeurosis respectively replace silk or catgut as suture material. The upper flap suture, which is left attached at its inner end to the pubis, is used to sew the conjoined tendon and internal oblique to the shelving edge of Poupart's ligament, and the lower flap suture, also left attached at its inner end, is used to repair the incision in the external oblique aponeurosis. The strips should be $\frac{3}{8}$–$\frac{3}{16}$ in. wide.

15. MacEwan (1886).—The sac is freed to a point 1 in. beyond the internal ring, and then folded into a pad and this pad sutured into the ring. Sutures are brought through the muscles above the ring, and then through the skin, where they are tied.

16. McGavin (1909).—After removal of the sac, the deep epigastric artery is divided between ligatures, and a filigree is placed on the posterior wall of the inguinal canal and retained by suturing the internal oblique muscle to Poupart's ligament. The cord is replaced and a second filigree inserted under the external oblique aponeurosis.

17. Marey (1881).—High ligation of the sac, transplantation of the cord, and repair of inguinal canal. Sac tied with double suture of kangaroo tendon; suture by interrupted stitches of conjoined tendon to Poupart's ligament with kangaroo tendon.

18. Scott (1905).—As Bassini, suturing the internal oblique strongly against the cord. In order to avoid tension when the internal oblique and conjoined tendon are sewn to Poupart's ligament, a relaxing incision is made through the fascia at the outer edge of the rectus. (A similar method has recently been described by Tanner, 1942.) The external ring is obliterated and the cord brought out halfway along the line of suture of the aponeurosis.

19. Stein (1939).—Ligature and excision of the sac. A flap of fascia covering the internal oblique is dissected down and sutured to Poupart's ligament.

20. Stetten (1923).—This is one of many modifications of Bassini in which the external abdominal ring is obliterated by repairing the divided external oblique aponeurosis *behind* the cord, which thus comes to lie subcutaneously.

21. Torek (1906).—As Bassini, except that all structures are dissected from the cord so that only the vas deferens and the vessels remain. Sutures are placed so that the vessels and the vas are separated, the former lying to the outer side.

22. Watson (1916).—Modified Bassini. The modification is that the upper leaf of the external oblique aponeurosis is dissected free from the internal oblique, and the cord made as thin as possible by dissection, leaving only vas and vessels. It is then placed high on the surface of the internal oblique, and held there with one or two stitches. The flaps of the external oblique are then overlapped, the upper one beneath the lower.

MODERN TIMES

Can we claim to have advanced in the surgery of hernia since the days of Bassini and Halsted? Beyond the use of fascial sutures I cannot find much evidence for this, though the literature since that time is vast, and beyond the bounds which time for reading it sets. What advance there has been is certainly out of all proportion to the amount of literature put out.

The reasons for the attention paid to hernia are its frequency of occurrence and the uncertainty of its cure. It has been said that in the United Kingdom alone there are 2,000,000 hernias—though Army surgeons will probably argue that this estimate can no longer be accurate—they have done them all, mostly single handed! I am not able to give exact figures of incidence, but from experience of military surgery can testify to the great frequency of hernia among the young manhood of the country. In one 600-bedded military hospital alone, 634 operations for hernia were done between March, 1941, and October, 1942 (nineteen months). Of 1300 recruits entering an intake camp in July, 1941, no less than 143 had hernias. To quote more figures would be superfluous. I think it has been a revelation to everyone how common a thing it is.

What are the results of surgery? Many series of figures have been published, for both indirect (external oblique) and direct. Let us concern ourselves first with the former. Different 'follow-ups' show a wide variation in recurrence rate, from the 0 per cent of some to over 20 per cent of others. To quote all published figures would be worthless. There are so many variants affecting the statistics that little value can be gained by detailing them. One of the important variants is in the criteria of recurrence adopted—an important point. A small though definite bulge after operation may be discounted by some—and this will reduce the recurrence figure by 50 per cent according to Grace and Johnson (1937).

There are indeed so many variants that it would be irrational, as Shelley (1940) has pointed out, to conclude that because one type of operation resulted in a low recurrence rate it should be applied to all hernias.

There is one set of figures, however, fully worthy of quoting, because they are illustrative of the results of surgery which is at least of average quality, if not above, for this country. They are published under the ægis of Max Page (1943).

They appear in two series, and are based on operations upon policemen at St. Thomas's Hospital, London. The first series was worked out by N. R. Barrett, and the second by A. G. MacPherson.

1934

Operation	*No.*	*Recurrence*	*Recurrence Rate*
No repair (excision of sac only)	29	4	13·8 per cent
Fowler	144	31	21·5 per cent
Bassini	36	8	22·5 per cent
Other methods	4	—	—
Total recurrence			20·5 per cent

1942

Operation	*No.*	*Recurrence*	*Recurrence Rate*
Excision of sac only	86	8	9·3 per cent
Fascia lata repair	39	6	15·4 per cent
Other methods (Bassini, 7; Fowler, 6; McArthur, 3; Bloodgood, 1)	17	3	17·6 per cent
Total recurrence			12·0 per cent

In eight years, the recurrence rate has dropped by 8 per cent, but the most noteworthy feature in both series—especially the later one—is that the results of simple ligature and excision are easily superior to those of all other operations. It may be thought that this is because only early cases were selected for this operation, but this cannot be so for there is no reason to suppose that the 1934 hernias were more long-standing and serious than the 1942 cases, and yet only 29 of 213 in the first series were treated by simple herniotomy and no less than 86 of 142 in the second series.

A further insight into the distressing frequency of recurrence may be gained by the study of figures from military sources. No less than 805 operations for recurrences were performed during six months of 1942 in military hospitals alone, and this probably represents only 60 per cent of all recurrent hernias examined. Nearly all of them were operated upon the first time before enlistment, and they came from all parts of Great Britain and Northern Ireland. The results were, therefore, representative of British Surgery as a whole. Further evidence of a high recurrence rate may be obtained from convalescent depots. At one, 10 per cent of 125 hernias were recurrent and at another 16·6 per cent of 72 cases. It is not known exactly what proportion of these cases were originally direct hernias, but the reader can be assured that most of them, by far, were of the indirect type.

There is no need to search further. Recurrence after hernia operations is extremely common, and we must admit that, whatever results the expert may claim with *his* operation, *in his own hands*, at least 12 per cent of patients operated upon for indirect hernia in this country suffer recurrence.

Interval between Operation and Recurrence.—Published figures show most recurrences to take place during the first year, the curve falling rapidly during the second year. Longacre noted that 72 per cent of recurrences were in the first twelve months, and 87·2 per cent in the first twenty-four months.

Max Page noted that of 28 recurrences, 10 were in the first six months. My own figures in 88 cases show that 63·7 per cent recurred during the first year, 22·1 per cent in the second, and the remaining 14·2 per cent after the second year.

Judd (1908) records that 70 per cent of his recurrences were noted in the first six months and 90 per cent in the first twelve months, and Erdman (1923), 73·9 per cent in the first twelve months and 98·6 per cent in the first twenty-four months.

These figures relate to the time the patient became aware of the recurrence, and are thus not indicative of the time herniation recommenced, which is probably at a much earlier date. It is highly probable that nearly all recurrences commence within a few months after the patient is convalescent from the operation.

CAUSES OF FAILURE

In our efforts to improve upon these results our researches should be first directed to the possible causes of failure. Let us consider them under these headings: (1) Surgical technique. (2) Type of operation. (3) Suture material. (4) Duration of hernia before operation. (5) Age. (6) General physique. (7) Anæsthesia. (8) After-treatment.

1. Surgical Technique.—My respected senior colleague, Mr. H. A. T. Fairbank, once said to me, "You can judge the worth of a surgeon by the way he does a hernia". The truth of this has been apparent to me on many

occasions. It is a delight to see the mature and skilled abdominal surgeon methodically yet speedily undertake this difficult operation.

Hæmostasis is perfect, aseptic precautions exact. The tissues are handled with care: exposure is adequate and every stitch placed with precision and with meaning. We cannot all perhaps perfect our art to this ideal, but can attempt to approach it. The nervous, careless, or 'rapid' operator should have no place in the treatment of hernia, which is always a difficult operation to perform. Certainly the trainee in surgery should not be allowed to gain his surgical experience at this operation without the most careful supervision. Not until hernia is regarded as a major surgical procedure, and reserved for the knife of the experienced surgeon, can we hope, whatever the actual operation done, to approach 100 per cent success.

Longacre (1939) found the recurrence rate after operations by house officers to be 6·8 per cent, and by members of the staff 6·3 per cent. The house officer is, however, assisted by a member of the staff at each operation, so that the figures are not significant.

It goes without saying that whatever else be done, success cannot be achieved unless the sac is ligatured high, and by transfixion.

2. Type of Operation.—Ogilvie, with his gift for lucid expression, has during the past ten years made efforts, not without success, to shake surgeons from their complacency over the surgery of hernia, and to challenge the infallibility of Bassini's method.

A considerable and increasing body of opinion, largely inarticulate, is following him. The argument is largely this:—

a. Indirect hernia is due to the presence of a congenital sac, and its cure depends on the complete removal of the sac.

b. The integrity of the inguinal region depends upon the normal unhampered action of the musculature, and any operative procedure which interferes with normal working of the musculature diminishes the strength of the abdominal wall, and tends to favour rather than prevent recurrence.

This cannot be gainsaid—as witness, the high percentage of cures in children after simple ligature and excision of the sac. But the presence of a hernial sac for any length of time causes a stretching of the internal ring, and does irreparable damage to the muscular mechanism, from which recovery is impossible or unlikely. In such an event, as the muscles become incompetent, artificial repair must be attempted.

The problem is twofold: (*a*) To ascertain whether or not the musculature has been stretched beyond repair. (*b*) To design a plastic operation which will effectively reduce the size of the enlarged internal ring without interfering with what muscular control still remains.

The theoretical criticism of the Bassini operation and all allied operations—e.g., Halsted, Fowler, Fergusson, MacEwan, etc. (*see* pp. 173, 174), is that in the early cases where the ring is either not stretched or only very slightly so, they are unnecessary. Added to that, by interfering unnecessarily with the muscular apparatus, they tend to favour recurrence. Surgical interference has been committed.

In cases where the ring is stretched, it will be admitted by everyone that some form of repair is necessary, and, I think that one will be best suited and most secure which least interferes with the musculature. The desideratum is to close the defect by inserting a mass of tissue there—either fascia, or floss silk, or even a metal grid.

Now let us turn to an analysis of personal experience upon operations on recurrent hernia, and judge to what extent fact agrees with theory. During a space of nineteen months in a Military Hospital, Major (now Lt.-Col.) Capper and I operated between us upon 131 recurrent hernias. All were in men of military age, 72 being between 20 and 30, 52 between 30 and 40, and 7 over 40.

The types of recurrence were as follows:—

a. External oblique (indirect), the new sac passing through the internal ring in association with the cord. This occurred in 98 cases (75 per cent). Of these recurrences, 77 per cent had appeared within eighteen months of the first operation.

b. Direct. These were of two types.

i. A diffuse bulge, with a saucer-shaped sac; of these there were 20 (15 per cent).

ii. A funicular sac coming through a well-defined opening in the transversalis fascia just lateral to the outer border of the insertion of the conjoined tendon. There were 13 (10 per cent).

Three-quarters of the recurrences were, therefore, indirect (or external oblique). In other words, the original hernia was reproduced. This is somewhat higher than in other published figures, but may be taken as reasonably representative.

Previous Operation.—It was not always possible at the second operation to find out exactly what had been done at the first, for the tissues were often so matted together as to give the impression that a mild degree of sepsis had followed the first operation. Those who believe that mild sepsis is an advantage—and there are many—and will help, by increasing fibrosis, to secure against recurrence, would be disillusioned by a study of some of the cases. Nothing could be further from the truth than that extensive matting together of the various muscle layers will strengthen the inguinal canal.

In 86 of the 131 cases it was possible to say with reasonable certainty what was the previous method:—

53—Bassini, or a minor modification.
9—Wyllys Andrews.
3—Bloodgood.
2—McArthur.
19—Sac only.

After those operations of the Bassini type in which the conjoined tendon had been sutured to Poupart's ligament, the internal oblique in most cases was represented by a thin sheet of attenuated muscle, pale brown in colour, and it is unlikely that in this state it could exercise much control over the internal ring. In two cases where silk had been used the stitches had cut through the muscle-fibres and remained attached to Poupart's ligament. The conclusions were that in general this type of operation results in a weakening of the normal mechanism of the canal.

In 19 cases in which ligature and excision of the sac only had been performed, the musculature was comparatively undamaged.

In a personal examination of 125 hernia cases operated upon between two and three months previously, notes of the details of the operation were to hand in 52. Of these, 34 were Bassini or a modification, 9 were repair by floss silk, 7 by fascia from the thigh, and 2 the sac only.

The impression from this examination was that the immediate results of the Bassini operation were not such sound repairs as in those done by floss silk and fascia.

3. Suture Material.—Catgut, thread, Chinese silk, floss silk, fascia, homologous and autogenous—which shall we use? Apart from the type of operation, has the suture material itself any influence upon results? Most writers who express opinions on this point condemn catgut. Longacre (1939) does so in no uncertain terms. He declares that with indirect hernias the 'catgut' recurrence rate is 12·5 per cent and the silk 3·4 per cent, and with direct hernias 13·6 per cent as compared with 4·49 per cent.

One is prepared to accept that silk (or thread) is more reliable than catgut, because of its permanency, but few will be prepared to accept so great a difference in virtue as Longacre maintains. Barclay (1937) favours silk, and so do Ogilvie (1937), Maingot (1941), and a host of others. Many older surgeons, who have successfully used catgut for many years, will contest this. For fifteen years I had the privilege of associating with two surgeons of great distinction, one of whom used thread for practically everything except intestinal suture, and the other used catgut exclusively. Successes and failures attended both—equally. There is throughout surgery, however, an increasing tendency to use unabsorbable suture material for nearly all purposes, and surgeons are constantly forsaking catgut for thread, and silk and even cotton. This tendency is likely to increase on grounds of economy and ease of sterilization, apart from other factors. It may possibly be one of those changes of fashion which from time to time cloud over scientific judgement and take control. Who can say but that in the decades to come a reverse process will be set into motion?

It must be conceded, however, that unabsorbable sutures are considered to be preferable to catgut at the present time for hernia operations. Floss silk is a specially prepared silk designed for strength and treated to create a fibroblastic response in the tissues. It cannot be sterilized by boiling. It was popularized by Rodney Maingot as a suitable substitute for fascia in performing a lattice repair for large inguinal hernia. Lt.-Col. Capper and I have used it for this purpose in 219 consecutive cases of hernia repair, and at that time we were pleased with it. But late results showed that the inclusion in this region of the body of this mass of foreign material was not infrequently followed by sepsis. I am told by Major Geoffrey Darke that many patients operated upon by us months ago, whose immediate result was satisfactory, are now returning with sinuses due to delayed infection. I have heard similar views expressed by other surgeons, and have seen in various hospitals many soldiers with discharging sinuses after the use of floss silk—one still incapacitated ten months after operation. Though at one time a professed enthusiast for lattice repair by floss silk, I now make a plea for its abandonment. Sepsis, immediate and late, is not uncommon, at least in military and E.M.S. surgery, and the effects of sepsis are disastrous. In Maingot's hands, however, the results have been excellent.

Fascial Sutures (transplanted).—Bendick (1937) contends that sepsis is more frequent if fascia is used instead of silk. Of 975 operations in which fascia was used 29·1 per cent recurred, and he therefore would now use it only for more difficult types of hernia. Sepsis was a common adjuvant cause of recurrence, but was less (7·9 per cent) when autogenous fascia was used than when homogenous (12·8 per cent) or ox-fascia (12·1 per cent) was used. These figures for infection are very high indeed. His criterion of infection was, of course, very strict. I do not think Bendick's experience is shared in any clinics in this country. In Major Williamson's recent excellent review (1941) of 163 operations for inguinal hernia in most of which fascial sutures were used, sepsis was not, apparently, a common complication, although it seemed responsible for recurrence in two cases. Behrend (1937) contends that the use of fascia reduces the risk of recurrence even in the presence of infection. The general opinion seems to be that infection is more common with fascia than with ordinary methods of repair, and this is only to be expected because of the longer exposure of the wound and the preparing of the fascial strips. Beekman and Sullivan (1939) state, after experience with 2000 hernia cases, that both wound infection and respiratory complications were much more frequent when the operation took a long time. Scarcely any trouble is met with after an operation lasting ½ hour, but if it takes 1½ hours 25 per cent of patients suffer from one of these complications. Because of these added risks one should hesitate before adopting fascial sutures as a routine for all hernias except those in children and young adolescents, as advocated by Masson (1935) and Williamson.

One important criticism of the use of fascia is the damage done to Poupart's ligament by the large holes produced by the clumsy Gallie needle which, according to Bendick, leave weak areas. What of the leg after the Gallie operation? Does any incapacity—or morbidity—arise because a portion of fascia lata is taken from the thigh?

Opinions differ here—largely, I feel, from prejudice, the attempt to uphold or condemn the method according to preconceived views. As a result of seeing a large number of military personnel in whom fascia has been taken from the thigh so that a large muscle hernia is present, I have come to the following conclusions: (*a*) A muscle hernia results in a lump upon which the patient may hang symptoms, which are difficult to discount. (*b*) In the good type of patient a muscle hernia does not reduce efficiency to any notable extent. (*c*) In the poor type of patient, especially a soldier, complaints will be made. He will always have a lump to produce should he wish to shirk an unpleasant task.

In military surgery, on the whole, there is a good deal of disadvantage in dealing out a muscle hernia at random—a disadvantage which may not apply in equal force to civilian surgery.

For these reasons fascial transplants from the thigh should not be used as a routine, but reserved for those cases, e.g., long-standing or recurrent hernias, in which other methods are likely to to fail.

Incision or fasciotome?—In skilled hands, the fasciotome, leaving as it does minimal scars, is obviously superior to the method of exposing the fascia by incision, though in the absence of a suitable instrument one need not fear the incision. It heals well, gives rise to no discomfort, and is unlikely to cause symptoms afterwards. I have rarely seen any trouble associated with it, although on two occasions I have seen the development of a hæmatoma, followed by sepsis, after the use of a fasciotome.

It may be mentioned here that it is quite safe to implant fascia lata from one individual into the hernial region of a second—a convenient practice sometimes when one is dealing with several hernias in the same operation list.

Filigree Operation.—This method, developed by McGavin, and now practised successfully by Cole, has met with a very limited popularity. For further information the reader is referred to Cole's recent article (*Brit. J. Surg.*, 1941, **29**, 168).

4. Duration of Hernia before Operation.—The sooner operation is attempted after a hernia appears, the better the prospect of cure, as Shelley (1940) points out. This fact illustrates the importance of the abdominal musculature in maintaining the integrity of the abdominal wall, for the longer a hernia persists, the greater will be the stretching of the internal ring and the greater the incompetency of the muscle. It is important to realize this and to impress it upon the patient to prevent him from "seeing how he gets on for a bit" before submitting to operation.

5. Age.—Despite some claims to the contrary, the older the patient the worse the result. This has been clearly shown by Grace and Johnson (1937) in analysing the results of operation in 1032 patients over 50, in which there was a primary mortality-rate of 3 per cent. The recurrence rate for primary hernia for 659 patients was 25·8 per cent and for recurrent hernia 34·0 per cent. Many are those who claim success in nonagenarians and let all credit be given to them. Yet in older people, disappointment must be anticipated by a realization of the malign influence advancing years exerts upon surgical success.

6. General Physique.—Poor physical specimens are clearly not good subjects for operation, and in the flat-footed, round-shouldered, pot-bellied type, the enthusiasm of the surgeon should be tempered by the remembrance of past failures.

From the military standpoint, the position as regards selection of cases is clear cut. The question is—will operation make this man a more efficient soldier? No operation should be done unless the answer is 'Yes'. It is a poor military economy to operate upon a soldier already in a permanent low category on account, say, of foot defects unless the prospect of permanent cure is very good.

Chest complications, usually not serious ones, are common after hernia operations, and cannot but exert harmful effect upon lines of repair. It is of the utmost importance, whatever the type of operation to be performed, that the patient is well and free from any kind of infection at the time of operation.

7. Anæsthetic.—The choice of anæsthetic does not appear to affect the result. Longacre found the recurrence rate after general anæsthesia to be 7 per cent, after spinal to be 7·5 per cent, and after local 8 per cent respectively.

Chest complications are relatively common after operation for hernia, whether a local, spinal, or general anæsthetic is used. Generally speaking local anæsthesia is regarded as the method of choice in the U.S.A. and on the European continent and spinal or inhalation anæsthesia in this country.

My own preference is for spinal, largely, I think, because we were fortunate in having the services of Major Clausen, *M.C.*

8. After-treatment.—How long should a patient (*a*) be completely rested after operation; (*b*) avoid all strain after operation.

a. Period of Rest.—There is a wide divergence of opinion as to the optimum time for rest in bed. A surgeon in the Air Force recently declared in public that he advocated getting up the day after operation. He was all for "getting cracking". I remember a surgeon who even excelled this at "getting cracking". He used to operate for hernia under local anæsthesia and send the patient home by taxi.

It is as well to remember that it was Bassini's custom to place the patient in a plaster-of-Paris

cast, and to keep him in bed for six weeks. Perhaps the results of his operation would be better to-day amongst his followers if such rigid post-operation rest were enforced.

The period of recumbency enjoined by different surgeons seems to be based largely on guesswork. When the patient is up and about, there is no doubt that the operation area is subjected to stresses and strains which it is ill prepared to bear. On the other hand prolonged recumbency predisposes to constipation, and internal abdominal stress as an inevitable consequence. There will be, in addition, a general loss of muscular tone. Those that depend on a plastic operation to prevent recurrence, and not the strength of the muscular mechanism, should, if logical, raise no objection to this. I have so many times heard of life-long devotees of the Bassini operation declare that patients should not be kept abed after the stitches are out. The fact seems to be that if one excises the sac only without interfering with the musculature, early ambulation does not have any malign influence except that it goes counter to the sound and age-long practice of resting a wound until it has healed. If this operation is combined with careful repair of the transversalis fascia (as described subsequently) then weight-bearing upon the scar should be avoided until the fascia has healed, and this is adjudged to take three weeks.

If a plastic operation—Bassini, or by fascia, or what you will—of the inguinal canal is relied upon, then it surely goes without saying that weight-bearing should be postponed until the *scar tissue* upon which the union of the deep layers depends has consolidated, and this means a minimum period of three weeks.

It is on this reasoning that I recommend that all patients should, after a hernia operation, spend three weeks in bed.

b. Avoidance of Strain after Operation.—It is frequently the custom to warn the patient on his discharge from hospital, somewhat vaguely, not to lift anything heavy, or subject himself to any strain for several months. Nothing could be less helpful or less in keeping with a scientific outlook. The demands of war have forced us to reconsider the whole question of hernia repair in relation to strain. It is our endeavour not to make the soldier avoid strain, but to teach him to withstand it, so that he can reach maximum efficiency as a fighting man in minimum time. It is the military practice so to rehabilitate the soldier after a hernia operation that three months from the date of operation he can, without harmful effect, perform a 12-mile route march in full battle order, and go through the modified assault course established at our convalescent depots. All this has been successfully accomplished during the past eighteen months and is now routine. There were no recurrences during the three-months' period amongst the cases in the series I have quoted.

The weight borne on the lower abdominal wall and thence on a hernial scar in the erect position is considerable, for the inguinal canal is almost horizontal, and at the lower extremity of the abdominal cavity. The transition from lazing in bed for three weeks to walking about is an abrupt one and is more forceful if the muscles be allowed to waste into flabbiness. For this reason the gradual tuning up of the muscles is, in itself, desirable while the patient is still recumbent. The main reason for taking steps to tune up the muscles is, however, to reduce the time taken for a fighting man to reach physical perfection.

The muscle building is achieved by set exercises in bed (*see* Appendix, p. 184) and these exercises are commenced on the eleventh or twelfth day and are carefully graduated, and continued through convalescence in a gradually extended form until discharge from the convalescent depot, from whence the warrior departs in full kit.

The routine adopted is this: (i) Three weeks in bed, graduated abdominal exercises commencing on the eleventh or twelfth day; (ii) Three to four weeks in a convalescent home, where exercises are continued; (iii) Four to five weeks in a convalescent depot, where eventually the full range of P.T. is practised.

It cannot be claimed that the practice of these exercises reduces the recurrence rate. There is, however, one inestimable advantage they posses when employed in hernia wards in military hospitals, for they are a form of treatment which the patient feels, mentally and physically, to be beneficial, and this is sound psychology.

COMMENTARY

The task of fitting together this great jig-saw puzzle of facts, half facts, theories, and impressions into a complete whole is a difficult one. Whatever line of approach is chosen, it soon becomes obvious that many large pieces are missing.

Literary, conversational, and practical researches indicate definitely that the surgery of hernia is far from satisfactory, and that so far no known operative technique is proof against recurrence. There are these incontestable facts:—

1. At least 12 per cent of the inguinal hernias operated upon in this country recur.
2. The Bassini operation, or one of its modifications, is still the most popular operation performed.
3. About three-quarters of these recurrences are external oblique, i.e., through the internal ring in association with the spermatic cord, and most of them recur during the first year.

DISCUSSION

The Bassini Operation

Were there no variants, such as poor selection of cases, varied standard of surgery, etc., the case against the Bassini operation would appear to be absolute; as it is, however, the evidence is only circumstantial. Too much must not be blamed upon indifferent surgery—though this I believe

to be an important factor, as already indicated—for we have before us the figures of a high-class teaching hospital.

The most striking factual evidence which may be brought to bear against Bassini's method is the vast number of modifications that various surgeons have thought it necessary to adopt. There can be only one reason for this—the results of the Bassini operation in their hands were not satisfactory. If we exclude McArthur's modification (1904), which McCloskey and Lehman (1940) declare to give the best results, and which Longacre (1939) finds to give slightly better results in poor physical subjects, there is no evidence to be found that any of the modifications give better results than the original Bassini.

All these operations have one thing in common—the internal oblique and conjoined tendon are sutured to the dense fascia constituting Poupart's ligament. In this technical step must, therefore, be the fault.

There are these questions to be answered:—

1. Does the muscular tissue of the internal oblique and the rigid mass of the conjoined tendon unite by fibrous tissue to Poupart's ligament?

2. If union does occur, is the normal action of the internal oblique interfered with?

3. Is the integrity of the musculature of the inguinal canal an important factor in maintaining the normalcy of the inguinal mechanism.?

To question 1 the answer in 'not invariably'. The internal oblique and conjoined tendon are retained in situ after the Bassini operation only if unabsorbable sutures are used—and even these cut out on occasions, as I know from experience. To question 2 the answer is 'yes'. Not only is the action of the internal oblique interfered with, but as the result of operation its muscle-fibres may show actual degeneration in the neighbourhood of their new attachment. To question 3 the answer in 'yes'. This can easily be proved at operation by inserting a finger in the internal ring and asking the patient to strain, or asking the anæsthetist to make him cough. It can be demonstrated clinically in a thin patient if the scrotum be invaginated sufficiently. The force of contraction is surprising.

One of the methods adopted in Eastern Europe in the past to evade military service was to stretch the external ring, the canal, and the internal ring by invaginating the scrotum regularly with the forefinger. By this means a hernia could be induced.

Finally, let us ask—Is the rationale of reinforcing the posterior wall of the inguinal canal based upon sound reasoning? Stein concludes that suture of conjoined tendon to Poupart's ligament is fallacious because: (1) There is no weakness in the floor of the canal. (2) Nowhere in human economy is muscle used as a buffer state. It has four functions—motion, locomotion, control, and stabilization. (3) Muscle fixation is bound to result in atrophy from disuse, and if sutures give way, muscle is weaker than before and recurrence more likely.

We know that three-quarters of the recurrences do not come through the posterior wall of the canal at all, but through the internal ring—the original hernia is reproduced. Once a hernial sac commences to form, it is doubtful whether any plastic operation superficial to or on a level with the musculature of the ring can affect its progress. The critical point is not, in fact, that which the Bassini operation attempts to safeguard.

The Bassini operation, unless a satisfactory substitute is not available, should, therefore, be abandoned, because: (1) It has been found wanting as judged by results; (2) It offends against pathological, physiological, and anatomical principles; (3) It does not safeguard the critical point of recurrence.

The Alternatives to the Bassini Operation

We have a choice of two, and which is adopted will depend largely upon our individual conception of the importance of the musculature and of the aetiology. They may be described, as Max Page (1943) has suggested, as the harmony method and the hammer method.

In the first, the sac only is excised and the musculature untouched, and in the second, physiology is thrown on the scrap heap, no reliance is placed on the competency of muscle, and every part of the inguinal canal, external above and mesial to the cord, is filled in with unabsorbable material or, more desirable, fascia lata.

1. Simple Herniotomy.—This is the ideal, for it is least traumatizing, it removes the cause, and does not interfere with the musculature. But there are one or two qualifying factors. It is unlikely to succeed when the sac is so large that the internal ring is widely stretched, so that the inguinal mechanism is rendered incompetent. For such cases the method of the hammer must be employed.

Most hernias in young men belong to the first group—"It is a rupture that you may easily heal".

It is axiomatic that *no* operation will succeed unless the sac, preferably with any fat surrounding the cord at the internal ring, is completely removed. But that is not enough. The first line of defence—the transversalis fascia, *must be* repaired. This essential point in technique is widely neglected. I have heard this transversalis fascia held in considerable derision. I am told it is flimsy stuff, or that often it cannot be seen. To that I would say two things, to those who doubt: (*a*) Examine the boundaries of the internal ring in a cadaver; (*b*) Do at least one intraperitoneal operation for hernia.

The Operation—Herniotomy for Indirect Hernia.—The technique of this operation is so well known, and has been described so many hundreds of times, that a description of it by me would be

an obvious presumption. I beg leave, however, to draw attention to one or two of those steps in the operation upon which I think success largely depends.

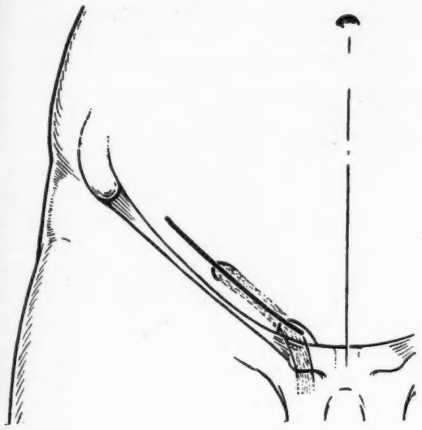


FIG. 151.—The incision. It should extend well outside the position of the internal ring, in order that the latter may be adequately exposed.

i. *Incision.* I believe it is best to use the standard incision which runs parallel with Poupart's ligament, and ½–¾ in. above it, because it gives the best exposure. It should commence well outside the situation of the internal ring, and halt at a point just internal to and above the pubic

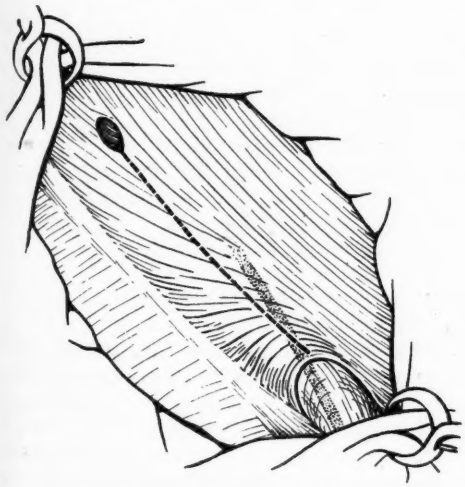


FIG. 152.—The incision in the external oblique aponeurosis is commenced lateral to the position of the internal ring and carried inwards to the external ring, which is not completely divided, to avoid injury to the ilio-inguinal nerve (shown in dotted line).

spine. The skin and superficial should be separated from the external oblique aponeurosis by gauze dissection, both above and below, so that a complete exposure of the canal is obtained. All vessels should now be tied (*Fig.* 151).

ii. *Skin guards.* The skin edges should be completely shut off, care being taken at the angles of the wound, and a clean knife and forceps used subsequently.

iii. *Incision through external oblique aponeurosis.* This should start from a point outside the situation of the internal ring and carried down as far as

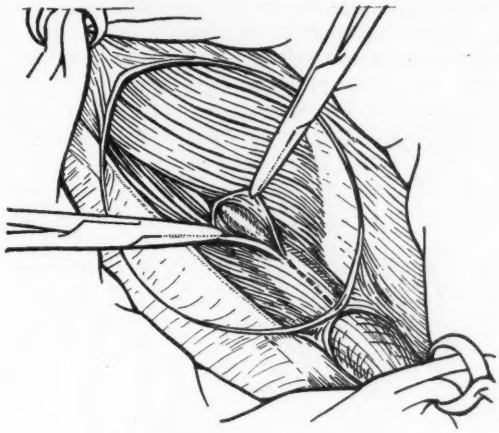


FIG. 153.—Incision of cremaster.

(but not through) the outer pillar of the external ring. If made, as it often is, along a dissector inserted under the outer pillar of the external

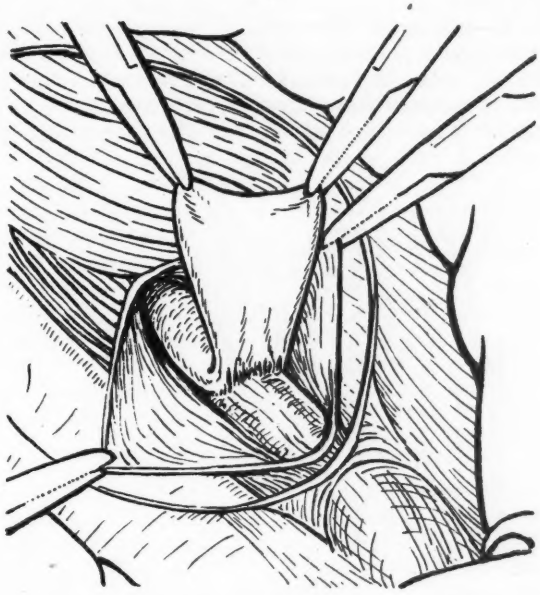


FIG. 154.—Dissection of sac. The cord mesial to the sac may be steadied by holding with Littlewood's forceps.

ring, the inguinal nerve may be damaged (*Fig.* 152).

iv. *The cord.* The cord should not be disturbed from its bed, but the sac dissected free through an incision in the cremaster muscle parallel with the cord (*Fig.* 153).

v. *The sac.* The sac is dissected free from all fascia until the intra-abdominal peritoneum is reached. For this to be done properly the external oblique and transversalis are firmly retracted outwards. Ligature is by transfixion by silk or thread (*Figs.* 154, 155).

vi. *The transversalis fascia.* By firm retraction of the outer pillar of the internal ring the transversalis fascia will be exposed, and the defect

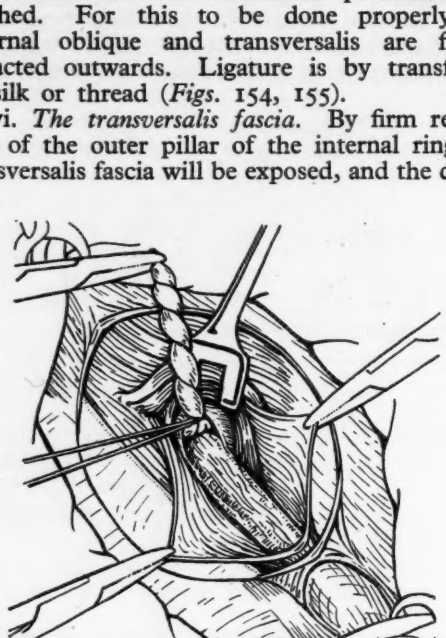


FIG. 155.—High excision of the sac after transfixion.

in it—a ragged one—should be repaired. This is a very important step. For this a U suture of thread, silk, or fascia obtained from the upper leaf of the external oblique aponeurosis should be used. The suture passes from the upper edge of

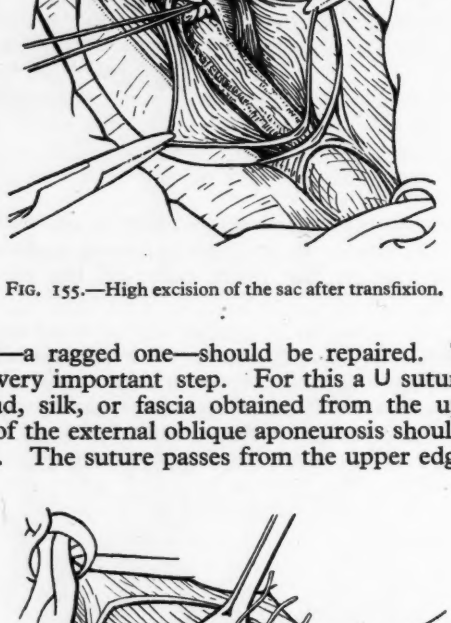


FIG. 156.—Repair of the transversalis fascia. The outer and upper margin of the internal ring should be firmly retracted.

the transversalis fascia, through the lower leaf of the cremaster muscle, to the deep aspect of Poupart's ligament and back again. More than one suture may be needed (*Fig.* 156).

vii. *Closure.* The cremaster, external oblique, and superficial fascia are repaired by interrupted sutures, and the skin incision accurately closed (*Fig.* 157).

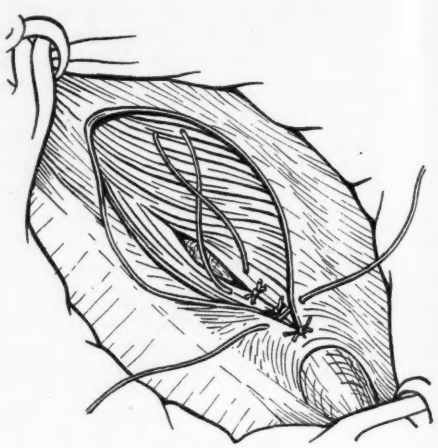


FIG. 157.—Closure of cremaster and external oblique by interrupted sutures.

viii. *Dressing.* Bulky dressings are to be avoided—they encourage infection. The wound should be well sealed off by elastoplast (*Fig.* 158).

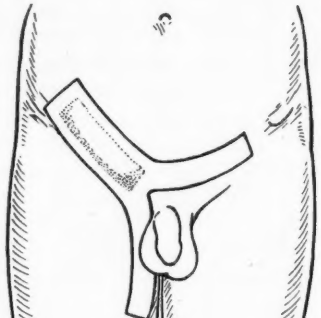


FIG. 158.—The dressing.

2. The Method of the Hammer.—If the ring is large, the patient of poor physique, darning with fascia lata is performed. Enough fascia for a thorough repair should be taken. Most surgeons are of the opinion that insufficient can be obtained from the external oblique itself, and therefore fascia lata must be used. The method described by Gallie (1921) is recommended.

DIRECT HERNIA

This is entirely a different problem from that of the indirect hernia, for the protrusion is due to an acquired defect of the thin posterior wall of the inguinal canal. The essential of operative treatment is to repair the defect. The results of surgical treatment are on the whole disappointing, but this is not contrary to expectation, for, unlike the treatment of congenital hernia, we are unable

to eliminate the cause and are limited to repairing the weak area.

Published results show a recurrence rate of anything between 7·8 per cent (an unusually low figure referred to by McCloskey and Lehman) to 35 per cent (Page). Apart from difficulties of actual operative repair, other factors exist which help to explain the general high recurrence rate, the two most important, perhaps, being age and physique. The age incidence is naturally higher than that for indirect hernia, and the physique of the patient usually below average.

There are two distinct types of direct hernia, the diffuse (soup plate) and the funicular.

1. **Diffuse Hernia.**—The recurrence rate after operation is undoubtedly very high, and it is in this type of hernia particularly that the most careful selection of cases for operation should be made if we are to avoid continued disappointment. Many cases are bilateral in a patient of advancing years with poor abdominal musculature and an emphysematous chest: such cases are best treated conservatively, for these hernias never strangulate and rarely descend into the scrotum.

The operation most likely to be successful in this type of hernia is repair by sutures of fascia lata.

2. **The Funicular Type.**—As far as I can ascertain, Ogilvie in 1937 was the first to draw attention to this hernia as a definite type. His publication at that time did not attract my attention, but during experience of military surgery I have met with the condition no less than sixteen times.

In its best defined form, the hernia possesses a well-defined sac about the width, and often the length, of the first finger, and comes through a small opening in the transversalis fascia behind the external abdominal ring, immediately lateral to the rectus sheath and well above the pubic crest. The sac is of stout peritoneum, and as a rule well clothed with fat, and closely resembles in external appearance the sac of a femoral hernia.

Unless the surgeon is aware of this type of direct hernia he will readily miss it at operation. The possibility of its existence must be born in mind when no sac is found in the inguinal canal on exploration for hernia which first appears after 30; and most important of all in operations for recurrent hernia.

A very striking fact emerged from Lt.-Col. Capper's analysis of military cases previously referred to. Of the 16 cases of funicular direct hernia met with in 632 operations for hernia, of which 501 were first-time operations, and 131 recurrent cases, 3 of the 16 were 'primary' and 13 were recurrent. In other words, the percentage finding of the type of hernia amongst first-time cases was 0·6 per cent and in recurrent cases 12·2 per cent. Two possible explanations exist: (*a*) The usual type of plastic repair practised for indirect hernias produces a weak area in the transversalis fascia; and (*b*) This type of hernia is frequently missed at the primary operation.

I do not know which explanation is the true one, but I am inclined to think that some cases are explained by (*a*) and some by (*b*). Eight of the 16 occurred shortly after the first operation, 5 of them during convalescence. These were probably missed at the first operation.

Eight of them occurred some time after operation, the average period being over two and a quarter years. Some of these at least appeared to have been acquired since the first operation. In one of them a silk stitch was found at the edge of the hernial orifice in the transversalis fascia, strongly suggesting that faulty technique at the primary operation was responsible.

With so well-defined a sac and such a small opening in the transversalis fascia, the results of operation upon this type of hernia should be satisfactory, though no figures are available to support this contention. For the first cases, it was our custom to darn the defect with floss silk, but later we used Keynes's (1927) modification of Bloodgood's operation.

Operative Technique.—The inguinal canal is exposed after complete division of the external oblique aponeurosis from the external to the internal ring. The sac, the neck of which is situated at some distance above the cord, is cleared down to the hernial orifice, which is enlarged by a small incision in the fascia passing obliquely outwards, parallel to Poupart's ligament. The sac, with its covering of fat, is excised flush with the peritoneum, and then later repaired by purse-string stitch or by transfixion and ligature. The defect in the transversalis fascia is repaired by interrupted stitches of thread or fine Chinese twist, being careful to avoid tension.

A triangular flap of the anterior sheath of the rectus, with its base at the lateral border of the muscle, is dissected up, and hinged outwards and downwards and sewn with interrupted stitches of thread to the shelving edge of Poupart's ligament. The flaps of the external oblique are now overlapped, leaving the cord superficial, and sewn together so that the external ring is obliterated.

THE RECURRENT HERNIA

This must be treated on principles which apply to first-time hernias. In early cases of indirect recurrence, due to incomplete removal of the sac, and when the muscles are not incompetent, simple ligature and repair of the transversalis fascia may be sufficient. In all others, repair should be by fascia lata, an ample supply of which should be obtained. Three strips are usually needed.

MISCELLANEOUS

The Abdominal Approach.—Edmunds, in 1910, advocated the abdominal approach for bilateral hernia, and this method was practised later by Cheatle. Latterly there has been an

increasing tendency toward the abdominal approach for single hernias, notably by Henry (1937) and Williams (1938). It is doubtful whether the method should be adopted as a routine, however, for we have yet to see whether the results are better than by the external approach, and it is probable that if adopted on a wide scale, figures for operative mortality and morbidity would rise.

Bilateral Hernia.—Should both sides of a bilateral hernia be operated upon at one sitting? It largely depends on the size of the hernia and on the patient's age. Sullivan (1939) says that complications after double herniotomy are twice as common as after simple herniotomy, so that the patient runs no added risk. However, no hard-and-fast line can be drawn, and surgeons should judge each case on its merits. In a young man,

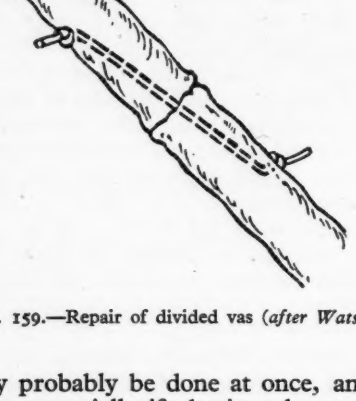


FIG. 159.—Repair of divided vas (*after Watson*).

both may probably be done at once, and in the older men, especially if physique be poor, it will usually be wiser to do them separately.

Complete Closure of the Inguinal Canal.—Occasionally in older men in whom repair of a large scrotal hernia is to be attempted, it may improve the prospect of a successful issue if the inguinal canal is closed completely. Bendick and Higginbotham (1935) show that it is unnecessary to remove the testis to accomplish this, but that the cord may be completely divided across without fear that the testis will slough.

Treatment of the Distal Portion of the Sac.—When the sac is large and thin and communicates with the tunica vaginalis, no attempt should be made to remove the distal portion, which may be treated by inversion after the method described by Jaboulay. In large recurrent hernias it may also be expedient to leave the distal part of the sac. There will be no need in such cases to perform Jaboulay's operation, but it is important to leave the sac open in order to avoid the development of a hydrocele.

Hernia and Undescended Testis.—The various problems associated with this condition cannot be entered into here, but in men of military age with a hernia where an undescended testis is present in the inguinal canal, any attempt to bring the testis into the scrotum after hernia repair is doomed to failure. It is best to amputate the testis with the hernial sac, and to close the inguinal canal completely.

Damage to the Vas.—This, of course, will never happen in the indirect hernia, and should not happen with any hernia. In operations upon hernias for the second or third time the anatomy may be so disturbed, however, that we may fall into the trap. The great thing is to recognize our mistake at once, and to repair the vas immediately. The method illustrated in *Fig.* 159 is probably the best.

SUMMARY AND CONCLUSIONS

1. Bassini's operation and its modifications should be abandoned.

2. For indirect hernias in muscular subjects where the internal ring has not been unduly stretched, simple herniotomy with repair of the transversalis fascia deep to the muscles at the internal ring is the operation of choice.

3. For large hernias, indirect or direct, primary or recurrent, Gallie's operation is the method of choice.

4. The funicular type of direct hernia, first described by Ogilvie, may easily be missed at operation. A satisfactory repair may be achieved by a modified Bloodgood operation.

5. Unabsorbable sutures should be used for hernia repair operations in preference to catgut.

6.—Hernia is a major operation, over which extreme care should be taken, particularly as regards hæmostasis and asepsis.

7. An average period of three weeks' recumbency should be enforced after operation.

8. Graduated rehabilitation exercises are beneficial from every standpoint, and hasten the return to physical fitness.

My thanks are due to Miss Mary Barclay-Smith for the illustrations.

APPENDIX

Bed Exercises after Operation.—

1. *Lying on the back.* Draw the knees up, sliding the foot along the bed. As a progression of this exercise the foot can be lifted off the bed for a moment when the knees are fully bent. Further progression should be made by lifting the feet from the bed with the knees less bent, until finally it becomes a straight leg raising to vertical. This should take from three to four weeks, the time depending entirely on the individual strength of the patient (rectus abdominis).

2. *Lying on back, knees fully bent, grasping sides of bed.* Roll the knees to left and right as far as they will go without discomfort, keeping the shoulders flat on the bed. Progressed by lifting the feet off the bed before starting the exercise. Further progression made by performing the exercise with the legs straighter until finally they are quite straight (internal and external oblique).

3. *Lying on the back.* Deep inhalation followed by full exhalation. When the lungs are empty, contract the abdominal wall and pull it in as far as

possible. A few normal breaths should be taken between each repetition (transversalis).

These exercises should be taught before operation, and started again about twelve days after operation. The number of repetitions will depend on the individual, but experience has shown that six times for each exercise is usual to begin with. The whole group should be done four times a day, and continued after the patient is out of bed.

REFERENCES

The literature on this subject is so monumental that it is impossible to abstract it fully. Much of it that is of importance will, however, be found in Leigh F. Watson's classic monograph, to the study of which I would commend all who are interested in this subject.

ANDREWS, E. W. (1895), *Med. Rec.*, N.Y., **9**, 67.
BARCLAY, W. (1937), *Ann. Surg.*, **106**, 363.
BASSINI, E. (1890), *Arch. klin. Chir.*, **40**, 429.
BATES, U. C. (1913), *J. Amer. med. Ass.*, **60**, 2032.
BEEKMAN, F., and SULLIVAN, J. (1939), *Surg. Gynec. Obstet.*, **68**, 238.
BEHREND, M. (1937), *Penn. med. J.*, **40**, 837.
BENDICK, C. G. (1937), *Ann. Surg.*, **106**, 333.
BENDICK, C. G., and HIGGINBOTHAM, H. L. (1935), *Ibid.*, **102**, 863.
BLOODGOOD, J. C. (1919), *Ibid.*, **70**, 81.
BRENNER, A. (1898), *Zbl. chir.*, **25**, 1017.
COLE, P. P. (1941), *Brit. J. Surg.*, **29**, 168.
DOWNES, W. A. (1911), *Ann. Surg.*, **53**, 568.
EDMUNDS, A. (1908), *Med. Pr.*, **85**, 348.
ERDMAN, S. (1923), *Ann. Surg.*, **77**, 171.
FALLIS, L. S. (1937), *Ibid.*, **106**, 363.
FERGUSSON, A. H. (1899), *J. Amer. Med. Ass.*, **33**, 6.
FOWLER, G. R. (1897), *Ann. Surg.*, **26**, 603.
GALLIE, W. E., and LE MESURIER, A. B. (1921), *Canad. med. Ass. J.*, **11**, 504.
GILL, W. G. (1939), *Brit. med. J.*, **1**, 263.
GRACE, R. V., and JOHNSON, V. S. (1937), *Ann. Surg.*, **106**, 347.
HALSTED, W. S. (1893), *Johns Hopk. Hosp. Bull.*, **4**, 17.
HENRY, A. K. (1937), *Proc. R. Soc. Med.*, **30**, 534.
HULL, A. J. (1913), *Ann. Surg.*, **58**, 479.
JOYCE, T. M. (1940), *J. Amer. med. Ass.*, **115**, 971.
JUDD, E. S. (1908), *J. Minn. med. Ass.*, **26**, 56.
KIRSCHNER. M. (1910), *Arch. klin. Chir.*, **92**, 888.
KEYNES, G. (1927), *Brit. med. J.*, **1**, 173.
LAROQUE, G. P. (1919), *Surg. Gynec. Obstet.*, **29**, 507.
LONGACRE, A. B. (1939), *Ibid.*, **68**, 238.
MCARTHUR, L. L. (1904), *J. Amer. med. Ass.*, **43**, 1039.
MCCLOSKEY, J. F., and LEHMAN, J. A. (1940), *Ann. Surg.*, **111**, 610.
MACEWAN, W. (1886), *Ann. Surg.*, **4**, 89.
MCVAY, C. B., and ANSON, B. J. (1942), *Surg. Gynec. Obstet.*, **74**, 746.
MAINGOT, R. (1941), *Brit. med. J.*, **1**, 777.
MAREY, H. O. (1881), *Tr. vii Internal med. Cong.*, **2**, 446.
MASSON, J. C. (1935), *Minn. med.*, **18**, 365.
OGILVIE, W. H. (1937), *Proc, R. Soc. Med.*, **30**, 529.
— — (1937), *Post-Graduate Surgery* (ed. R. Maingot), 3614.
PAGE, C. M. (1934), *Brit. med. J.*, **2**, 896.
— — (1943), *Proc. R. Soc. Med.*, **36**, 185.
SCOTT, A. C. (1919), *Texas State J. Med.*, **15**, 5.
SHELLEY, H. J. (1940), *Arch. Surg.*, **41**, 747.
SIMPSON-SMITH, A. (1939), *Brit. med. J.*, **2**, 990.
STEIN, H. E. (1942), *Amer. J. Surg.*, **56**, 480.
STETTEN, D. (1923), *Ibid.*, **78**, 48.
SULLIVAN, J. E. (1939), *Surg. Gynec. Obstet.*, **69**, 1052.
SUTTON, L. E. (1936), *Ann. Surg.*, Sept., **104**, 403.
TANNER, N. C. (1942), *Brit. J. Surg.*, **29**, 285.
TOREK, F. (1906), *Ann. Surg.*, **43**, 665.
WATSON, L. F. (1932), *Hernia*, 2nd ed. London.
WEST, E. T. (1938), *Sth. med. J.*, **31**, 726.
WILLIAMS, C. (1938), *Ann. Surg.*, **107**, 917.
WILLIAMSON, J. C. F. L. (1941), *Brit. J. Surg.*, **28**, 384.
ZIMMERMAN, L. M. (1938), *Surg. Gynec. Obstet.*, **66**, 193.

CERVICAL RIB SYNDROME ASSOCIATED WITH A CONTRACTING LESION OF THE APEX OF THE RIGHT LUNG

BY A. L. D'ABREU

LIEUT.-COLONEL, R.A.M.C.

CASE REPORT

MRS. M. B., aged 29, was first seen in March, 1939, at the Birmingham Anti-Tuberculosis Clinic suffering from cough and hæmoptysis. The sputum was negative for tubercle bacilli, but these were detected in the fæces. A radiograph (*Fig.* 160) showed a large cavity surrounded by tuberculous infiltration in the right upper lobe; the upper lobe showed considerable contraction and the upper septum was densely thickened. A fully developed cervical rib articulating with the left first rib and a much enlarged seventh right transverse process (well seen in *Fig.* 161) were noted. There were no symptoms or signs in either upper limb of cervical rib pressure.

The Treatment and Course of the Tuberculous Disease.—Treatment consisted of a right artifical pneumothorax associated with a sanatorium régime. In spite of the presence of obvious apical adhesions, a fair collapse-relaxation of the diseased upper lobe was obtained and a disappearance of the cavity was accompanied by a marked improvement in the surrounding infiltrative process. All symptoms steadily disappeared and there has been no return of cough, sputum, or hæmoptysis. In November, 1940 (17 months after the induction of the pneumothorax), she recommenced work as a clerk, refills being maintained at the Out-patient Clinic until May, 1942, when, in spite of all efforts to maintain the air space, obliteration was taking place rapidly. She was then completely free from all signs and symptoms of active tuberculous disease; fibrosis and contraction of the upper lobe were associated with a sudden and pronounced deviation of the trachea to the right.

The Development of the Cervical Rib Syndrome.—As the pneumothorax became obliterated and the contraction of the right upper lobe and tracheal deviation were being accompanied by a noticeable falling in of the right upper chest, the patient became aware of tinglings and pins and needles in the right arm, forearm, and hand, and noticed a weakness in the grip of the right hand. In May, 1942 (35 months

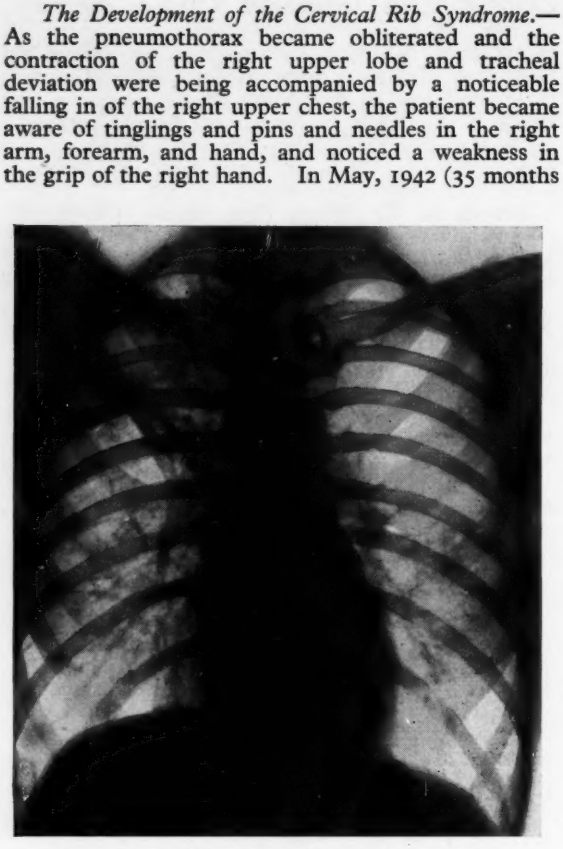


FIG. 160.—Radiograph showing cavity in right upper lobe, much tuberculous infiltration of upper two-thirds of right lung, and fully developed left cervical rib.

after the induction of the pneumothorax) the refills were abandoned and a right phrenicectomy was done to supplement the treatment of the tuberculous disease. To exonerate this operation from any mischievous interference with the brachial plexus it is important to note that the symptoms in the limb preceded the phrenicectomy !

Four months later, the classical picture of ' cervical rib ' pressure was obvious ; she could now hold a pen with the greatest difficulty, the small muscles of the hand were most wasted, especially those of the thenar eminence and of the interosseous spaces. The hand was blue and the radial pulse less forcible than that of the left side. A penetrating radiograph (*Fig.* 161) showed well the enlargement of the costal element of the seventh cervical transverse process, the dense fibrosis of the right apex, and the tracheal deviation. The general condition was excellent and the tuberculous disease appeared to be arrested. Operation in the expectation of finding a fibrous band running from the characteristically hooked costal element was advised.

The Operation.—Under general anæsthesia a supraclavicular transverse incision of 3 in. was made and the sternomastoid retracted towards the midline after division of some of its clavicular fibres. The scalenus anticus muscle was taut and spastic ; it was completely divided. The subclavian artery and the brachial plexus were seen to be lifted forwards by a hard fibrous band which passed down to the first rib ; the artery showed a considerable narrowing beyond the point of constriction ; it was separated from the surrounding tissues and retracted laterally by two pieces of linen tape. The band was then divided and most of it removed. The wound was then closed. The main contact of the band was made with the lower elements of the brachial plexus.

PROGRESS.—The colour of the hand was normal within four hours of operation and became warm. The paræsthesia had disappeared within a few days. Massage and faradism were given to the forearm and hand muscles. Three weeks after the operation she returned to her clerical duties and noted that she could do a full day's work without pins and needles and without hand fatigue. She has remained symptom-free, although the interosseous muscles are still not fully re-developed. The hand has remained warm and of normal colour.

COMMENTARY

This history is intended to indicate a point in the aetiology of the cervical rib syndrome ; it is universally accepted that the commonest age incidence of the symptoms, especially the neurological ones, is in the third and fourth decades, and is observed more commonly in women than in men, although the anatomical aberrations are seen equally in both sexes. A predominance of the syndrome in women has been attributed to the greater descent of the shoulder in them than in men at these ages ; the descent is accompanied by a similar change in the position of the first rib. This in turn leads to an increase in the tone of the scalenus anticus which may become spastic. Space between this muscle and the cervical rib (or unossified fibrous element) becomes lessened, and the brachial plexus, especially in its more caudal element, and subclavian artery become compressed and irritated. It is no part of this paper to inquire into the aetiology of the vascular change about which so much has been written. My object is to indicate that in this particular

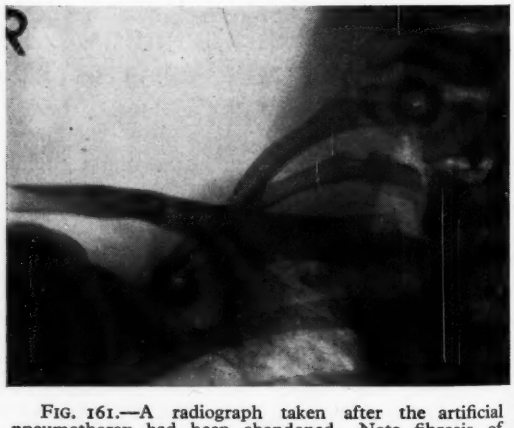


FIG. 161.—A radiograph taken after the artificial pneumothorax had been abandoned. Note fibrosis of right apex, the tracheal deviation, and the enlarged costal element of the transverse process of the seventh cervical vertebra.

patient the symptoms, both neurological and vascular, became apparent following a sudden and marked lowering of the first rib and of the

upper chest, the result of a contracting fibrous lesion of the apex of the right lung. It would seem highly probable that the cause of the symptoms was this pathologically produced descent. It is interesting to note that the fully developed cervical rib on the left side has caused no symptoms; it would, however, be unwise to draw the conclusion that symptoms have not developed on that side because no pathological 'descent' has taken place, since it is well recognized that symptoms are far commoner as a sequel to those lesser anatomical aberrations, such as a fibrous cord arising from an over-developed costal element, than to the perfectly developed accessory rib.

SUMMARY

1. In a tuberculous patient with a fully formed left cervical rib and an enlarged costal element of the right seventh cervical transverse process to which was attached a fibrous cord, the symptoms of right cervical rib syndrome developed after the upper part of the chest on that side had contracted.

2. It is suggested that this is additional evidence to support the view that cervical rib symptoms are precipitated by the descent of the shoulder in the third and fourth decades, a descent accentuated in this instance by a pathological process in the right hemithorax.

3. The symptoms were relieved by scalenectomy and division of a band.

I am much indebted to Dr. Todhunter and Dr. Woolf, of the Birmingham City Tuberculosis Service, under whose care this patient made such a good recovery from her tuberculous disease, for the use of their notes and opinions. Also to Mr. Smith, of the X-ray Department of the same Service, for his excellent radiographs and their reduced prints.

SHORT NOTES OF RARE OR OBSCURE CASES

CONGENITAL DIVERTICULUM OF THE BLADDER

By GEOFFREY KEYNES

AIR COMMODORE, CONSULTING SURGEON, R.A.F.V.R.

AND MERVYN MOREL

SQUADRON LEADER, SURGICAL SPECIALIST, R.A.F.V.R.

DIVERTICULA of the bladder have been reported in considerable numbers in recent years, two of the most notable contributions published in this country being the papers by J. Swift Joly (1923), 14 cases, and R. Ogier Ward (1938), 53 cases. It is well known that most bladder diverticula, though of congenital origin, do not give rise to symptoms before middle life, by which time cystitis is well established and the prostate often enlarged, so that operative proceedings have to be planned in relation to these facts. Of Joly's patients the youngest was 37, and the other thirteen were aged from 49 to 72. The average age of Ogier Ward's fifty-three patients was 57, ranging from 15 to 80. Only three, however, were under 40 and only ten others under 50. Clearly, therefore, it is very unusual for a patient with a bladder diverticulum to come to operation before the age of 30—only two being reported among sixty-seven.

In dealing with diverticula by operation, Joly remarks that there is "no set operation suitable for all cases", but that the procedure should be varied according to the position of the sac, the amount of inflammation around the bladder, the density of the adhesions around the sac, the size and position of the orifice, the condition of the bladder wall, and the degree of bacterial infection within it. He then offers three methods: (1) Excision from without the bladder, suitable for the diverticula situated high up in the fundus of the bladder, or in relation to the urachus. The bladder is opened and a finger is inserted into the diverticulum to assist in its removal. (2) Splitting the bladder wall down to the orifice of the diverticulum. The incision is carried round the orifice, and the diverticulum is then separated and removed. (3) Intravesical operations, by invagination of the sac, or by combined invagination and inversion.

Ogier Ward performed the majority of his 50 operations by the second of these methods. It is to be noticed that all the methods demand opening of the bladder, often with extensive injury to the bladder wall, and subsequent suprapubic drainage. For the elderly patients with severe cystitis this is no doubt the safest procedure, though convalescence will be prolonged. We place on record the following instance of diverticulum of the bladder in a young man in order to demonstrate that, in suitable circumstances, the bladder need not necessarily be opened, so that the period of invalidism will be materially reduced.

FIG. 162.—X-ray film showing opaque catheters in right ureter and vesical diverticulum.

FIG. 163.—Same as *Fig.* 162 after opaque injections.

FIG. 164.—Diverticulum after removal. Arrow indicates the ligatured neck.

CASE REPORT

The patient was an airman aged 25. He had complained of frequency of micturition for as long as he could remember, and this had been worse recently, with pain and hæmaturia. He was admitted to E.M.S. and Royal Naval Hospitals in February and June, 1942, a diagnosis of "chronic *Bacillus coli* cystitis" being made; nothing beyond this was seen at cystoscopy, though the condition proved resistant to treatment. He was discharged to duty in July with considerable improvement. He was next admitted to a Royal Air Force Hospital on Sept. 14, 1942. In addition to the frequency of micturition he was complaining of pain in his left side and in the back, and also in the middle of the abdomen, especially after meals. Cystoscopy showed that the cystitis had not recurred to any serious degree and the bladder mucosa appeared normal. The mouth of a

diverticulum was, however, seen about one inch above and behind the right ureteric orifice, the margin being smooth and not inflamed. The size and position of the diverticulum were demonstrated by introducing opaque catheters into the diverticulum and the right ureter (*Fig.* 162), and by a cystogram (*Fig.* 163). It was seen that the diverticulum was fairly large, with a relatively narrow orifice rather low down near the ureteric orifice. The kidneys were proved to be both normal, the urine was sterile on culture, and the blood-urea was normal. Treatment with sulphanilamide had been found to maintain sterility of the urine, and it was therefore decided to attempt removal of the diverticulum without opening the bladder. The operation was performed on Nov. 4, 1942. The diverticulum was exposed retroperitoneally through a midline incision and was carefully freed from its surroundings. The ureter lying beneath it was adherent but was successfully separated, and eventually the diverticulum was isolated and its neck defined. The muscular and connective-tissue layers of the neck were incised all the way round, leaving the diverticulum attached to the bladder by a narrow passage of mucous membrane only. This was crushed, ligatured, and divided, and the short stump was buried by oversewing the muscular walls of the bladder. A drain was introduced through a stab in the flank down to the site of operation. The abdominal incision was closed, and the bladder was drained by an indwelling catheter. The patient was given sulphanilamide by the mouth for eight days, and the bladder was washed out once daily through the catheter for five days. The catheter and the pelvic drain were then removed, and the patient was able to pass urine naturally. Twenty-one days after the operation all wounds were healed and the former frequency of micturition was much reduced (D/N = 6/1–2). Cystoscopy one month after the operation showed a faint bluish mark on the bladder mucous membrane as the only remaining evidence of the former diverticulum. The patient was discharged next day from hospital with sterile urine and normal micturition.

The diverticulum after removal was found to have a capacity of about 20 c.c. The wall was thin and was composed mostly of fibrous tissue, but was shown by section to contain some muscular strands. The narrowness of the neck in relation to the fundus is well shown in the photograph (*Fig.* 164).

REFERENCES

JOLY, J. SWIFT (1923), *Lancet*, **2**, 445.
WARD, R. OGIER (1938), *Brit. J. Surg.*, **25**, 790.

BILATERAL ADENOLYMPHOMA OF THE PAROTID GLANDS

BY J. S. RAMAGE
HONORARY SURGEON, NORTH STAFFORDSHIRE ROYAL INFIRMARY
G. G. BINNIE
RADIOTHERAPIST, STOKE-ON-TRENT REGIONAL RADIUM CENTRE, NORTH STAFFORDSHIRE ROYAL INFIRMARY
AND A. J. McCALL
PATHOLOGIST, NORTH STAFFORDSHIRE ROYAL INFIRMARY

THE only previous description of bilateral adenolymphoma of the parotid glands appears to be that of Nino (1940). In the case now to be described tumours of this type were present in both parotids and an additional point of interest was the finding of two tumours in the right gland.

CASE REPORT

CLINICAL HISTORY.—A man, aged 65, was sent to the Stoke-on-Trent Regional Radium Centre on May 25, 1941. He complained of painless swellings on both sides of the neck. That on the right had been present at least fifteen years; that on the left for five years.

The tumours were centred behind the angles of the mandible, and though the right tumour appeared to be one rounded mass it was found at operation to consist of two separate tumours. The tumours were not fixed to skin and could be moved slightly over the deeper structures. Both were of elastic consistency, and fluctuation could not be elicited. The patient stated that the swellings had varied in size from time to time (*Fig.* 165.)

The diagnosis was uncertain, so an aspiration biopsy was taken from the right side and a course of deep X-ray therapy was begun. The material from the biopsy showed appearances corresponding closely with certain areas of the tumours described below and strongly suggested adenolymphoma. Professor T. B. Davie kindly examined sections from this material and considered that the tumour was certainly an adenolymphoma.

Three months later the tumours were much smaller, but surgical removal was considered desirable.

OPERATIONS.—The left tumour was removed first, and that on the right was removed a week later, the first tumour having been examined histologically in the interval. In each case access was obtained through a curved incision behind the angle of the mandible, and the tumours were found lying just beneath the parotid fascia. The mass on the right consisted of two separate tumours.

All the tumours were enucleated without difficulty from the adjacent parotid tissue, and both incisions healed without incident after drainage for 24 hours. The ease with which these tumours were removed without damage to the parotid tissue was in marked contrast to the conditions usually encountered in dealing with mixed tumours in this gland.

PATHOLOGY.—

Macroscopical Appearances.—

a. Tumour from left parotid: 2·5 × 2·0 × 1·75 cm.; 5·5 g.

b. Large tumour from right parotid: 3·5 × 2·5 × 1·5 cm.; 10 g.

c. Small tumour from right parotid: 1·1 cm. in diameter, roughly spherical; 3·5 g.

The gross appearance of the tumours is characteristic of adenolymphoma. The cut surfaces show pinkish-grey solid areas and cysts. The cysts contain fluid of mucinous appearance and in many cases are

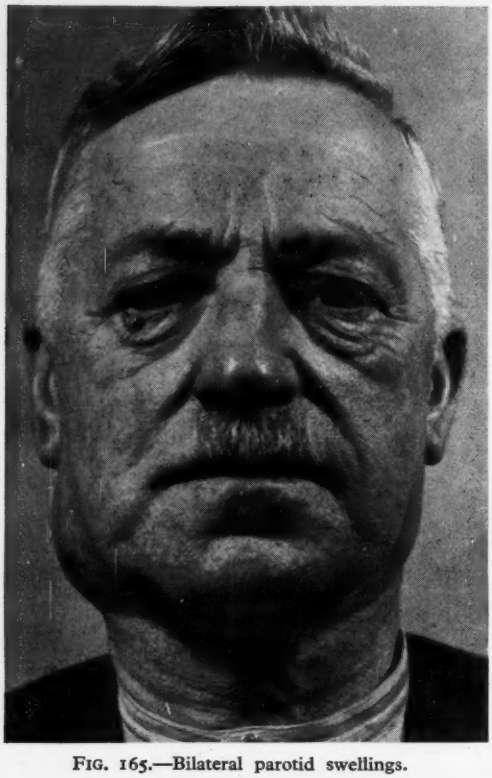


FIG. 165.—Bilateral parotid swellings.

almost filled with shaggy, grey papillary processes (*Fig.* 166). All the tumours appear to have a connective-tissue capsule, and a little parotid tissue is attached to (*b*).

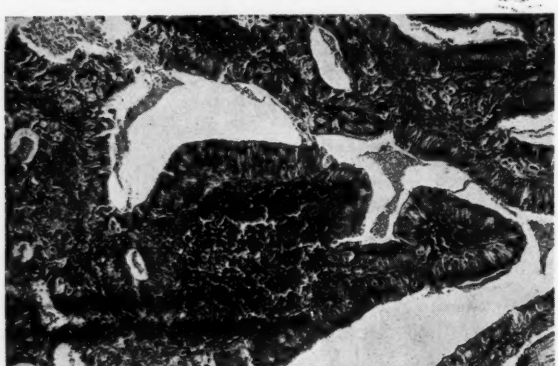


FIG. 167.—Intracystic papillary process with lymphoid stroma; tall columnar epithelium with nuclei towards lumen. (H. & E.) (× 60.)

Histology.—The three tumours show essentially similar appearances. The characteristic features are a peculiar type of columnar epithelium, an abundant lymphoid stroma, cyst formation, and intracystic papillary processes. (*Figs.* 167, 168.)

The epithelium lines the cystic spaces and covers the intracystic papillary processes. Generally it consists of a tall columnar palisade layer and a basal layer of smaller cells. The nuclei of the tall cells are

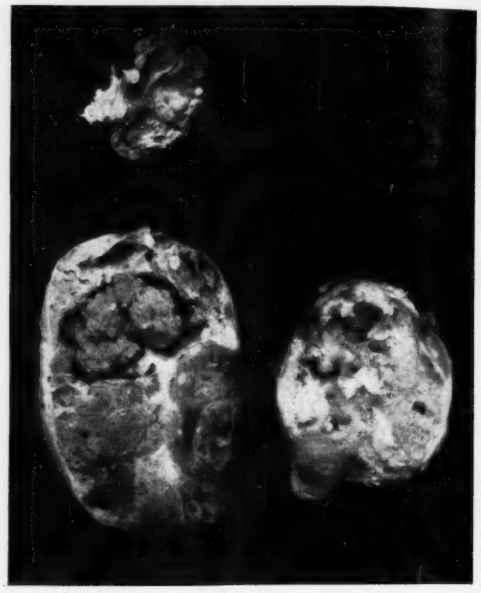


FIG. 166.—Two tumours from the right parotid (left of photograph) and a single tumour from the left parotid. A mass of intracystic papillary processes is shown in the larger tumour from the right gland. (*About natural size.*)

usually round and lie near the free border of the cells. The cytoplasm of the cells stains fairly strongly with eosin owing to presence of numerous minute eosinophil granules and a fine eosinophil reticulum. The basal cells are small and irregular in shape, but are similar to the tall cells in their nuclear and cytoplasmic staining.

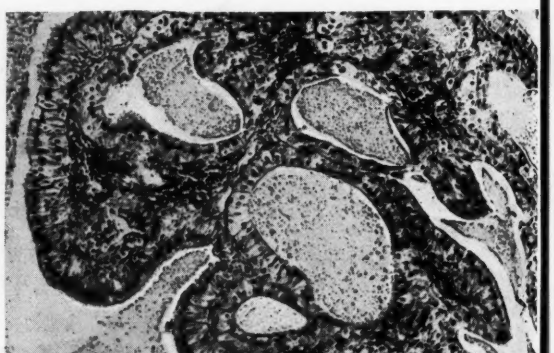


FIG. 168.—Intracystic papillary process with small cysts within it. (H. & E.) (× 120.)

In some areas the epithelium is several layers thick and in others it is reduced to a single layer of low cuboidal cells. Occasionally a more solid arrangement of the epithelium is seen, and in one tumour there is a small area of squamous epithelium.

The stroma consists for the most part of lymphoid tissue showing numerous lymphoid follicles, though in a few places it consists of dense collagen only. The epithelium is separated from the stroma by a thin basement membrane.

The cysts usually contain both fluid and papillary processes, though the latter are sometimes absent. In formalin-fixed material the fluid is faintly eosinophil and often contains both mononuclear cells and cholesterol crystals.

The papillary processes vary greatly in size, frequently show branching, and are formed by the epithelium already described supported on a stroma which is usually rich in lymphocytes.

Capsule.—A well-formed collagenous capsule surrounds each tumour.

DISCUSSION

Recorded Cases.—Albrecht and Artz (1910) gave the first clear description of adenolymphoma. Tumours recorded by Mermet (1896) and by Lecène (1908) may have been examples of this tumour, but in neither case is the description conclusive.

Carmichael, Davie, and Stewart (1935) were able to find records of 26 cases and added 8 of their own. Their paper gives a comprehensive account of these tumours. We have found the following additional cases recorded since their publication: Hall (1935), 1 case; Wood (1935), 3 cases; Oden (1935), 1 case; Krudestein (1935), 1 case; Bonifazi (1936), 1 case; Harris (1937), 2 cases; Nino (1940), 7 cases, of which 1 case was bilateral (only an abstract of this paper was available to us). Two probable cases are mentioned by Steinhardt (1933), and three papers recently published in enemy countries (*see* references, overleaf) appear to describe similar tumours.

In addition to the cases quoted above, tumours have also been described by Harris (1936), and Gruenfeld and Jorstad (1936), in which proliferating masses of epithelium and lymphoid stroma occurred as in typical adenolymphoma, but in which papillary processes were absent. It is probable that these were variants of adenolymphoma. It appears, therefore, that more than 50 examples of this tumour have now been described.

Clinical Features and Diagnosis.—Adenolymphoma is usually a slowly-growing tumour lying in or close to the parotid gland; more rarely the submaxillary gland is involved. The tumour may be demonstrably cystic. It is usually movable and is not attached to skin. Elderly males are most often affected. The age and sex incidence calculated from the available data is as follows:—

AGE DISTRIBUTION OF 37 CASES OF ADENOLYMPHOMA

The average age in 37 cases was 56·4 years, the cases being distributed as below:—

Decade	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
No. of cases	1	1	0	1	5	13	10	5	0	1

The ratio of males to females in 39 cases was 6·8 : 1

Points of distinction between adenolymphoma and the commoner mixed parotid tumour are the late age incidence of adenolymphoma, together with its more superficial situation, greater mobility, and usually softer consistency. The tumour may, however, be quite hard from accumulation of secretion, and rapid increase in size may occur from the same cause. It seems likely that the reduction in size that followed X-ray therapy in our case was due to diminished secretion.

Carmichael and his colleagues stated that there was no record of correct pre-operative diagnosis. In our case the nature of the tumour was established by aspiration biopsy, and this method is worthy of consideration in doubtful cases.

Malignancy and Recurrence.—Only two tumours, the first recorded by Ssobolew (1912) and the second by Stöhr and Risak (1916), were regarded as malignant. The only recorded example of recurrence appears to be a case described by Carmichael, Davie, and Stewart (1935); this tumour was not considered malignant. From our finding of two tumours in one gland it seems possible that a small tumour might be overlooked at operation and its subsequent enlargement be regarded as a recurrence.

The importance of distinguishing clinically between adenolymphoma and mixed tumour arises mainly from the ease of removal and infrequent recurrence of adenolymphoma. In a recent paper Patey (1940) advocated a more conservative attitude in dealing with mixed parotid tumours, as about 20 per cent of these growths recurred after operation and their complete removal was often a matter of extreme difficulty. It should be emphasized, therefore, that adenolymphoma is usually easily removable, and the risk of recurrence appears to be slight.

Histogenesis.—The hypotheses put forward to explain the origin of these tumours are discussed by Carmichael, Davie, and Stewart (1935). Suggested origins of the tumour include aberrant parotid tissue in the parotid lymph-glands, the branchial pouches, ectopic pharyngeal epithelium, and salivary-duct epithelium.

Jaffé (1932) suggested that the tumour be called an *onkocytoma*, believing that it originated from modified epithelial cells derived from either gland or duct epithelium and originally termed *pyknocytes*, but more recently renamed *onkocytes* by Hamperl (1931). Onkocytes are cells which closely resemble the epithelium of adenolymphoma, and Hamperl stated that they were to be found almost constantly in the parotid after the age of 60. He found them with equal frequency in both sexes, and suggested that adenolymphoma might arise from these cells.

Adenolymphoma and onkocytes are both found most commonly in late middle age, and this gives some colour to the view that the tumour arises from these cells. The equal sex incidence of onkocytes does not, however, explain the predilection of the tumour for males. Hamperl

noted proliferating masses of onkocytes associated with lymphoid stroma, and Steinhardt (1933), who made a similar observation, also described papillary hyperplasia of these cells with encapsulation. The occasional occurrence of bilateral tumours and of more than one tumour in the same gland might be thought consistent with the view that the tumours arise from onkocytes, since these cells are found bilaterally and in multiple foci.

Whether the onkocyte is an occasional or invariable stage in the formation of these tumours from gland or duct epithelium is at present uncertain. It is noteworthy, however, that adenolymphoma is a relatively rare tumour though onkocytes are said to be found with considerable frequency after middle age. It follows that if the tumour does, in fact, arise from onkocytes, then these cells can have but little tendency to neoplasia.

SUMMARY

1. A case of bilateral adenolymphoma of the parotid glands is described; two tumours were present on the right side. X-ray therapy was followed by a reduction in size.

2. The clinical features and diagnosis of these tumours are discussed and aspiration biopsy is advocated as an aid to diagnosis.

3. Previously recorded cases are briefly reviewed.

We wish to express our indebtedness to Professor T. B. Davie for examining slides from the aspiration biopsy.

REFERENCES

ALBRECHT, H., and ARTZ, L. (1910), *Frankfurt. Z. Path.*, **4**, 47.
BONIFAZI, E. (1936), *Helv. med. Acta*, **3**, 721.
CARMICHAEL, R., DAVIE, T. B., and STEWART, M. J. (1935), *J. Path. Bact.*, **40**, 601.
GRUENFELD, G. E., and JORSTAD, L. H. (1936), *Amer. J. Cancer*, **26**, 571.
HALL, E. M. (1935), *Arch. Path.*, **19**, 756.
HAMPERL, H. (1931), *Virchows Arch.*, **282**, 724.
HARRIS, P. N. (1936), *Amer. J. Cancer*, **27**, 690.
— — (1937), *Amer. J. Path.*, **13**, 81.
JAFFÉ, R. H. (1932), *Amer. J. Cancer*, **16**, 1415.
VON KRUDESTEIN, S. (1935), *Arch. klin. Chir.*, **182**, 828.
LECÈNE, P. (1908), *Rev. Chir., Paris*, **37**, 1.
MERMET, P. (1896), *Bull. Soc. anat., Paris*, **71**, 760.
NINO, F. L. (1940), *Bol. Inst. Clin. quir. B. Aires*, **16**, 271 (abst. in *J. Surg.*, 1941, **72**, 115).
ODEN, C. (1935), *Amer. J. Surg.* **30**, 57.
PATEY, H. P. (1940), *Brit. J. Surg.*, **28**, 29.
STEINHARDT, G. (1933), *Virchows Arch.*, **289**, 624.
STÖHR, F., and RISAK, E. (1926), *Arch. klin. Chir.*, **143**, 609.
SSOBOLEW, L. W. (1912), *Frankfurt. Z. Path.*, **11**, 462.
WOOD, D. A. (1935), *Amer. J. Path.*, **11**, 889.

Recently published papers, not available:—
PICCININI, P. (1940), *Arch. "de Vecchi" Anat. patol.*, **2**, 849.
SKORPIL, F. (1940), *Virchows Arch.*, **306**, 714.
VENZONI, M. (1940), *Arch. ital. Chir.*, **58**, 465.

ARTERIOVENOUS ANEURYSM OF THE POPLITEAL VESSELS—ARTERIORRHAPHY UNDER HEPARIN

By W. GRANT WAUGH

HONORARY ORTHOPÆDIC SURGEON, DARLINGTON MEMORIAL HOSPITAL; HONORARY ASSISTANT SURGEON, THE ROYAL INFIRMARY, SUNDERLAND

CASE REPORT

HISTORY.—David S., aged 24, a steel erector, had a machine-gun bullet wound on the outer side of the left thigh, while travelling in a train on Aug. 15, 1940. First-aid treatment was given at another hospital the same day; the wound appeared superficial, primary toilet and suture performed; the area was not X-rayed. The man returned to work four weeks later. In April, 1941, while working in the Orkneys, he sprained his ankle; when the limb was under examination for this condition the presence of an arteriovenous aneurysm in the popliteal space was detected. As the man lived in this area he was kindly sent to me by Lieut.-Colonel John Bruce, F.R.C.S.

ON ADMISSION.—An aneurysm the size of a golf ball was present, with the usual physical signs—pulsation, bruit, and thrill; a loud systolic bruit was audible in mitral area. Cardiac examination by my colleague, Dr. McIntosh Nicol, showed enlargement of the left side of the heart; general systolic B.P. 126, but systolic pressure at ankle, below the aneurysm, 110; the leg was cyanosed, but there was no œdema; there was a definite degree of distress on exercise tolerance tests.

OPERATION (July 12, 1941).—One c.c. of heparin was given intravenously every half-hour for two hours before and during operation. The popliteal vein and veins from the leg entering the sac were divided between ligatures and the sac dissected free (*Fig.* 169); the wound area was flooded with 2 c.c. of heparin and the pneumatic tourniquet inflated; the sac was then opened and contents cleared. A small metal fragment, previously recognized by X rays, was found to be lodged in the wall of the artery, its tip projecting into the lumen; removal of this was followed by a brief flow of arterial blood, after which the smooth intima was easily visible; five individual sutures of 000000 silk were passed through the outer coats, avoiding penetration of the intima, to close the aperture in the artery; when these were tied, the calibre of the vessel was reduced by about one-half. The anterior half of the sac was now removed and the posterior portion wrapped round the vessel to reinforce the suture line

(*Fig.* 170), and to reduce the risk of thrombus formation; the wound was closed; an Unna's bandage from the toes to groin was fitted. Persistence of thrill and bruit after the wound was closed was disconcerting until I remembered that this occurred after operation in many cases which I saw during and after the last war. In this instance I think it was due to the constriction of the vessel at the point of suture; but the phenomenon has been noted also in cases where the main vessel has been ligated and the sac excised, e.g., after operation for external iliac arteriovenous aneurysm.

PROGRESS.—Intravenous heparin was continued every four hours for five days and then discontinued as the posterior tibial pulse was good. Ten days later (two days after the Unna's bandage had been removed) the foot suddenly became cold, clammy, and painful, and the ankle pulse thin; heparin therapy was reinstituted by drip infusion, and contralateral immersion in hot water begun; these measures were successful, the circulation in the limb being fully restored in

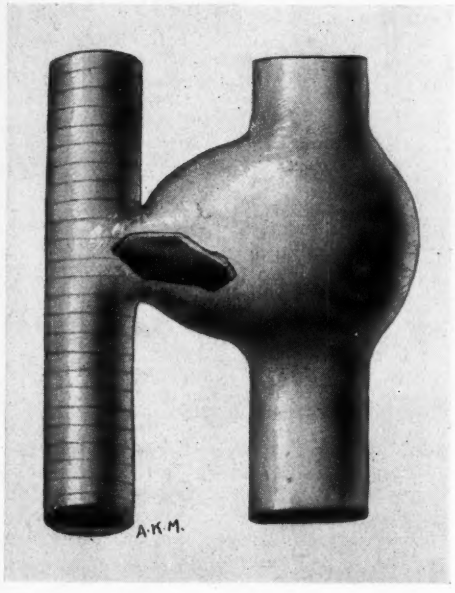


FIG. 169.—Diagram of condition after dissection.

sixteen hours. I had fears that a catastrophe was imminent, but now believe that the condition was sudden arterial spasm of sympathetic origin. There has been no recurrence and the patient has been back at full work, which involves climbing and working at heights, for fifteen months.

COMMENT

There can be little doubt that arteriorrhaphy is the procedure of choice in arteriovenous aneurysm, and that the prospect of successful repair is greatly enhanced by the use intravenously and topically of heparin.

To supplement the suture line with an endothelial support vicariously obtained from the aneurysmal sac may help to lessen the clotting tendency should minor extravasation take place between the sutures.

Contralateral heat according to Professor Learmonth's method should be available and, I believe, employed as a routine after ligation or

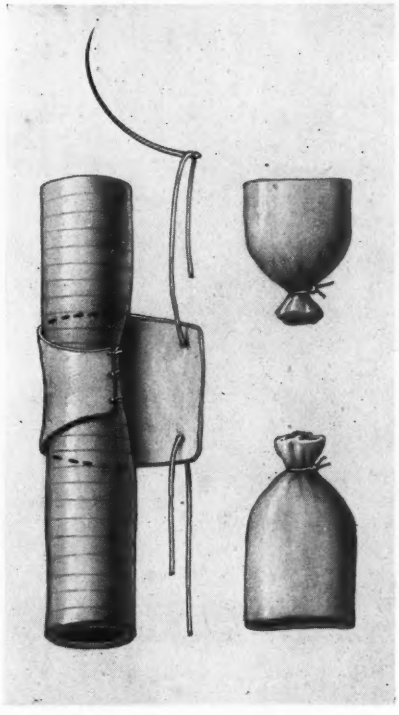


FIG. 170.—Method of reinforcing suture line.

suture of an artery; its value in averting ischæmic paralysis in supracondular fracture of the humerus is established.

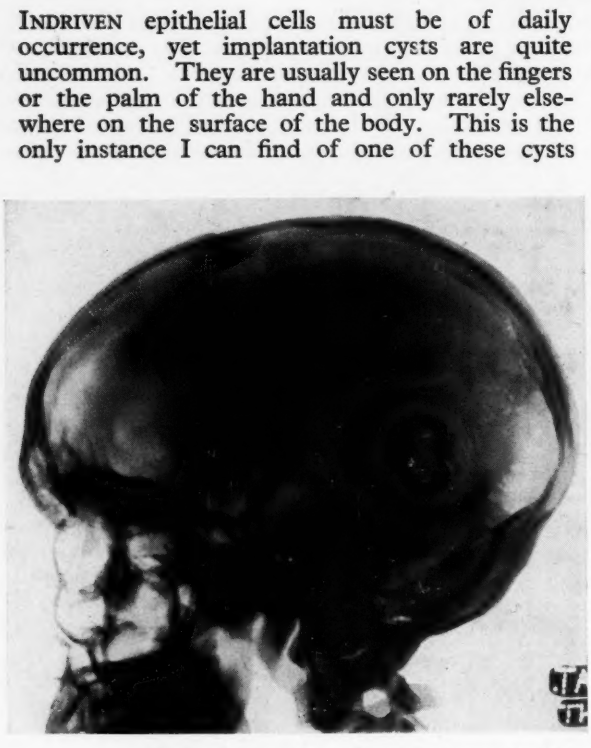
Statistical analysis of the desirability of operative intervention and of the relative values of ligation and arteriorrhaphy is difficult to find in the literature. The introduction of heparin as an anticoagulant has greatly enhanced the outlook for the latter procedure.

I venture to suggest the compilation of a register of traumatic aneurysms and arteriovenous aneurysms under the guidance of a member of the Medical Research Council. The majority of the cases will doubtless be patients of the Pensions and E.M.S. Hospitals.

SUBAPONEUROTIC IMPLANTATION CYST COMPLICATING DEPRESSED FRACTURE OF THE CRANIAL VAULT

By LAMBERT ROGERS
SURGEON CAPTAIN, R.N.V.R.

INDRIVEN epithelial cells must be of daily occurrence, yet implantation cysts are quite uncommon. They are usually seen on the fingers or the palm of the hand and only rarely elsewhere on the surface of the body. This is the only instance I can find of one of these cysts complicating a depressed fracture of the skull.* Diagnosis was intriguing because of the various possibilities presented by a lump appearing at the site of a previous depression in the calvarium.



FIGS. 171, 172.—Lateral and anteroposterior X-ray views of the skull, showing depressed fracture in the left parietal region.

CASE REPORT

HISTORY.—On Jan. 17, 1942, a marine, aged 21, was kicked on the head at football. He remembers the blow and that he tried to finish the game, but was too giddy to do so and could not control his limbs. He states that there was no cut on the head, only a "bump" on the left side. He was admitted to a hospital nearby and treated by a course of mild dehydration. X-ray examination revealed a depressed fracture in the left parietal region. He was soon free from symptoms and was given luminal and returned to duty. He then had occasional fits, but was otherwise well and had no headache.

On Dec. 23, that is, almost a year later, he was seen by Surgeon Captain Macdonald Critchley, who referred him to me. At this time there was a swelling about the size of a plum at the site of the old depressed fracture shown by X rays (*Figs.* 171, 172). The swelling, which was tense and slightly tender, was deep to the scalp, which moved freely over it. Electro-encephalography gave negative results on two different occasions.

OPERATION (Jan. 11, 1943).—A scalp flap was turned down over the tumour, which was found to be a cyst lying deep to the epicranial aponeurosis, intimately adherent to the pericranium of the depressed bone fragments, and when opened to contain the semi-solid, cheesy material characteristic of sebaceous and implantation cysts (*Fig.* 173). The defect resulting from removal of the depressed fragments of bone was closed by an outer table graft taken from an adjacent area of skull. Convalescence was uninterrupted and he returned to duty.

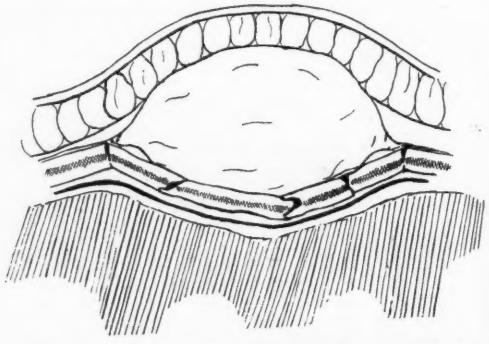


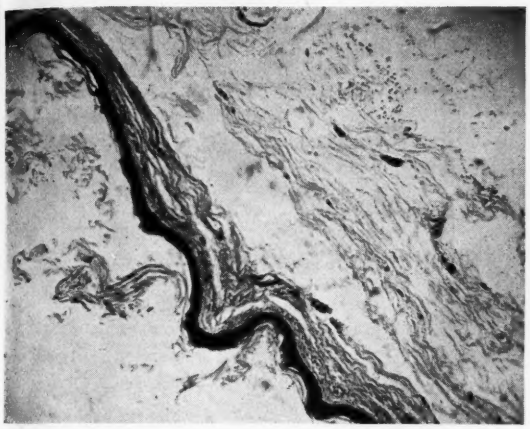
FIG. 173.—Diagrammatic representation of findings at operation, viz., cyst deep to scalp, intimately adherent to pericranium, and occupying site of the depressed fracture.

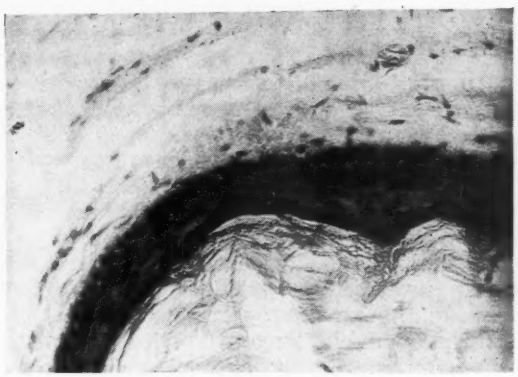
* I am indebted to the Librarian of the Royal Society of Medicine for assisting me in a search for a parallel case.

PATHOLOGICAL REPORT (Surgeon Lieutenant H. W. Clegg, R.N.V.R.).—The specimen consisted of an oval cyst, 1¾ in. by ½ in., not apparently attached to skin, and having a smooth greyish lining without any adventitial structures such as hair. The contents were cheesy and sebaceous in character.

Microscopically the cyst is lined with stratified squamous epithelium showing strata corneum, granulosum, and malpighium. The superficial layers of epithelium are being shed freely into the cyst cavity.

The epithelium lies upon connective tissue containing numerous blood-vessels and showing papillary formation. No true dermal structures could be seen in any part of the specimen (*Figs.* 174, 175).





FIGS. 174, 175.—Microscopical appearances. Low- and high-power magnifications of cyst wall.

COMMENT

This surgical rarity is worthy of report only because of the unusual site of the implantation cyst and the fact that it constituted a late complication of a depressed fracture. In these respects it is, as far as I can ascertain, the first example to be recorded. It is remarkable that these implantation cysts, which have received a variety of names such as dermal cysts, traumatic dermoids, etc., are not of more frequent occurrence, particularly as complications of operation wounds, but I have never seen one as such a complication. Sir John Bland-Sutton (1917) drew attention to their occurrence in the fingers, the cornea, and the iris, and once obtained a good example from the axilla of an ox. He described this cyst as the size of a billiard ball, and on dissection, as resembling a piece of inverted skin. He found that it was customary for the ox-drivers to prod their charges in the axilla with a sharp spike, so that a piece of epithelium may have been driven inwards by this means.

The case here reported reminds us that depressed fractures of the cranial vault should be elevated, compound ones as soon as possible, simple depressions with less urgency but at a convenient time soon after injury. Had this depression been thus elevated it is probable that neither the cyst nor fits would have complicated the injury.

I am indebted to the Medical Director General of the Navy and the Surgeon Rear Admiral, R.N. Auxiliary Hospital, Sherborne, for facilities for the operation on this patient.

REFERENCE

BLAND-SUTTON, SIR J. (1917), *Tumours, Innocent and Malignant*, 6th ed., London, Cassell.

ECTOPIC VAGINAL URETER

BY J. ALBAN ANDREWS

ASSISTANT SURGEON, ST. PETER'S HOSPITAL FOR STONE

AND HENRY K. VERNON

SURGEON, ST. JAMES' (L.C.C.) HOSPITAL

ECTOPIC ureters are a well-known anomaly. Most of the cases reported are in the female because they have led to the clinical paradox of incontinence of part of the urine, together with normal bladder control of the remainder, whereas in the male the opening of the aberrant ureter is above the external sphincter and does not cause incontinence.

The commonest site for an ectopic opening in the female is in the vestibule near the external meatus, and this is readily understandable when it is remembered that this structure, like the ureter, develops from the Wolffian duct. The vagina is Müllerian in origin and a true ectopic vaginal ureter is a very rare occurrence. The vaginal opening of these ectopic ureters is nearly

always on the anterior wall near the midline, but when the opening is near the cervix it tends to become more lateral. The rarity of a true vaginal ureter is illustrated by Deming's finding in 1936 that up till then only 23 cases had been reported since Depaul recorded the first case in 1852.

Only 5 cases with an ectopic ureter opening near the cervix in the lateral fornix have been traced after an exhaustive search of the literature. Emmett (1887) transplanted the ureter into the bladder, but the patient finally died. O'Connor (1930) transplanted the ureter into the bowel, and Deming (1936) performed a transperitoneal ureterectomy. In both cases the operation was successful. Depaul reported the findings of an autopsy on a newly-born child with exstrophy of the bladder and two completely separate vaginæ and uteri. The right ureter opened into the right vagina by a large opening, and the left ureter from an ectopic kidney communicated with the left vagina by a small opening. Murray and Ahmed (1941) describe the case of a little girl with a rudimentary ectopic right kidney which was pyonephrotic, and its ureter opened into the right lateral fornix. They successfully performed a nephro-ureterectomy.

The authors wish to report a case with an accessory vaginal ureter on the left side, opening in the left lateral fornix, and successfully treated by ligature only.

CASE REPORT

HISTORY.—The patient, a child aged 12 years in 1937, had incontinence of urine by day and by night since birth, but passed urine naturally and appeared to have complete control in so far as the bladder mechanism was concerned. Complete urinary investigation carried out by one of us (J. A. A.) when she was 3 years old had shown no evidence of abnormality of the urinary tract itself, but escape of urine via the vagina had been established. Cystoscopy had revealed two normal ureteric orifices and bilateral ascending pyelography had shown no abnormality of the renal pelves and ureters. At that time excretion urography was not available and the mother was advised to bring her daughter for another investigation when bigger but before she reached puberty. In 1937 she was admitted to St. Peter's Hospital for Stone.

ON ADMISSION.—A self-retaining catheter was left in the bladder and the vagina packed with ribbon gauze; 5 c.c. of 0·4 per cent indigocarmine were injected intravenously and the bladder urine drained into a bottle. In 1½ hours the gauze was removed from the vagina and the last inch or so, coming from the vaginal vault, was stained a faint blue; 12 c.c. of uroselectan were given intravenously a few days later, but no abnormality was detected on the films except a vague shadow suggesting a supernumerary pelvic ureter on the left side. Under general anæsthesia the vagina was carefully examined with a large flushing cystoscope, the hymen being sufficiently tight to allow distension of the vagina with fluid. What appeared to be a small orifice was seen on the left side of the cervix uteri and the finest ureteric catheter was made to engage the orifice, but could not be passed farther than this. The cystoscope was then removed and the small depression to the left of the cervix inspected after exerting traction on the latter with a volsellum forceps. The orifice would not allow the introduction of a filiform bougie. The remainder of the vagina and vestibule appeared normal. An intravenous injection of indigocarmine was given, but no blue appeared from the orifice after 20 min. In the absence of any clue to the situation of the accessory kidney, and because of its extremely poor function, it was decided to give a larger dose of uroselectan; 30 c.c. were injected and films taken up to 50 min. after injection. On the 30-min. film a shadow suggesting the presence of an accessory calix above the left kidney was evident, and at 50 min. a double ureter was clearly seen (*Fig.* 176). On the strength of the evidence operation was decided upon.

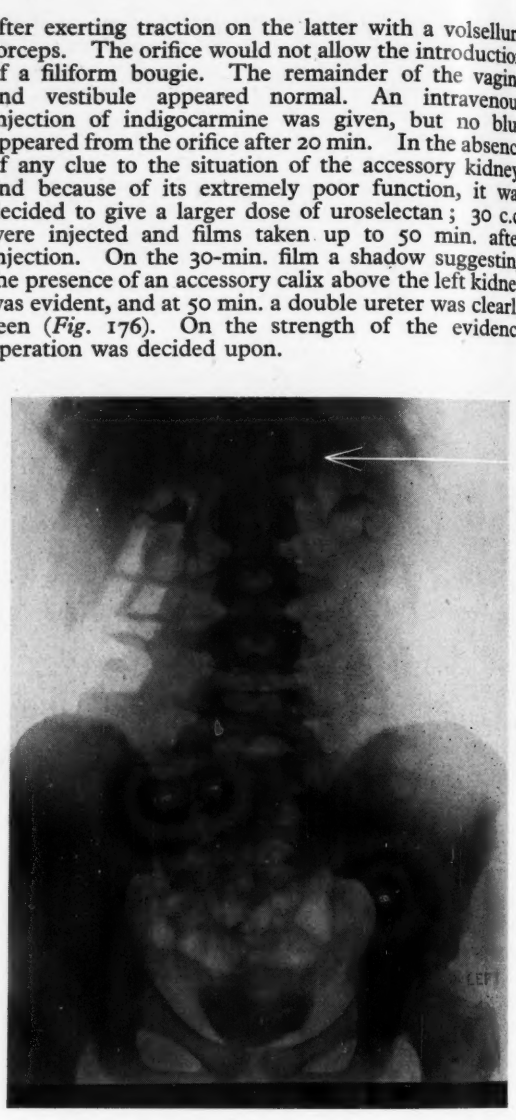


FIG. 176.—Radiograph taken 50 min. after intravenous uroselectan, showing accessory calix and ureter on left side.

OPERATION.—A ureteric catheter was passed from the bladder up to the left kidney, and with this lying in situ an incision was made in the left loin. Two ureters were easily demonstrated. The lateral one was the normal ureter because the catheter within it was easily felt. The two were not in a common sheath, but approximately ¼ in. apart. The medial ureter came from an accessory calix and was dilated. It was traced down to the pelvic brim and there it crossed to the lateral side of the normal ureter. The accessory ureter was divided and an olivary-tipped bougie was passed down it for about 8 in. and was then obstructed. The point of the bougie could be felt on the left of the cervix by a finger in the vagina and movements of the bougie made from the wound in the loin were transmitted distinctly to the finger in the vagina. Owing to the small size of the accessory kidney and the absence of any evidence of infection, the simplest procedure of ligation of the divided ends of the aberrant ureter was adopted, and the wound

closed round a drainage tube. There was no incontinence of urine from the day of the operation. For eight days the patient's temperature was in the region of 100° F., but was normal by the ninth day and remained so.

Since the operation the child has been perfectly normal, and on Dec. 14, 1942, her mother wrote in answer to an inquiry, saying, " she has had no return of bladder or kidney trouble of any sort since the operation ".

DISCUSSION

The poor function of the accessory kidney and dilatation of the ureter and pelvis above an ectopic ureteric opening, have been noted several times. In Deming's and Murray and Ahmed's cases the function was so poor that no shadow was thrown by the accessory kidney after intravenous uroselectan. In our case it was only after a large dose of uroselectan that the situation of the supernumerary calix was demonstrated. This was no doubt due to prolonged obstruction at the abnormal meatus. The treatment of cases with a vaginal ureter has been a matter of much discussion. Vaginal ligation of the aberrant ureter when this opened low in the vagina has met with failure in two-thirds of the cases in which it has been done. Re-implantation into the bladder has been more successful. When the truant ureter opens into the lateral fornix these methods would be very difficult and hazardous procedures. Apart from partial nephrectomy the only method of treatment that has met with complete success is abdominal ligation with or without partial resection of the aberrant ureter. When infection is present or the ureter drains an appreciable amount of functioning renal tissue, the objection to simple ligation is obvious. If, as in our case, the function of the accessory kidney is very poor and no evidence of infection is present, simple ligation and division of the ureter offers a simple and perfectly safe method of treatment.

SUMMARY AND CONCLUSIONS

1. A case with an accessory ureter opening into the vaginal vault is recorded.

2. A large dose of uroselectan may be necessary to demonstrate the situation of the offending ureter.

3. A plea is made for simple ligation when the aberrant ureter drains a small and uninfected portion of kidney tissue.

REFERENCES

DEMING, C. L. (1936), *Surg. Gynec. Obstet.*, **62**, 843.
DEPAUL (1852), *Mém. Soc. Biol.*
EMMETT (1887), *Pratique des Maladies des Femmes.*
O'CONNOR, V. J. (1930), *J. Urol.*, **23**, 376.
MURRAY and AHMED (1941), *Indian med. Gaz.*, **76**, 718.

A CASE OF INTUSSUSCEPTION OF THE APPENDIX

By ANDREW N. McCREA
SENIOR RESIDENT SURGEON, HIGHGATE HOSPITAL
AND BRUNO GANS
LATE ASSISTANT MEDICAL OFFICER, HIGHGATE HOSPITAL

CASE REPORT

The patient, a boy aged 2 years, 11 months, previously quite healthy, was admitted to Highgate Hospital on Nov. 14, 1942. For three weeks he had complained intermittently of abdominal pain and had vomited frequently. His bowels had only acted every two or three days. The intensity of his symptoms had been variable, sometimes allowing him to be up and playing, while at other times they were so severe that he was kept in bed. On one occasion, ten days before admission, blood had been noticed in the stools. The boy had wasted noticeably.

ON ADMISSION.—The child was dehydrated and shocked. Abdominal examination revealed an elongated mass in the region of the descending and iliac colon. When examined rectally a worm-like, firm object 1 cm. in diameter, the upper end out of reach of the finger, was palpable, extending to within 4 cm. of the anus. The significance of this finding was not realized at the time, especially since a second rectal examination failed to confirm it. A diagnosis of intussusception was made and after resuscitative measures, including an intravenous drip infusion of plasma and saline, operation was undertaken.

AT OPERATION.—Under gas, oxygen, and ether anæsthesia the abdomen was opened by a right paramedian incision. The intussusception was found to have advanced to the region of the pelvic colon and was readily reduced round to the right iliac fossa. The cæcum was then delivered from the wound and the appendix found to be completely inverted, or intussuscepted, into the cavity of the cæcum. The mesenteriole was drawn into a dimple situated at the normal site of origin of the appendix, while the latter was readily palpable through the wall of the cæcum. A short longitudinal incision was made through the cæcal wall to display the contained appendix. The picture presented was exactly as depicted in Mowat's (1938) illustration. The mucous membrane was congested and showed commencing gangrene at the tip. A ligature was applied at its base and the appendix amputated inside the cæcum. The incision in the latter was then closed in a transverse direction by two layers of sutures and the abdominal wall closed in the usual way.

No complications referable to the abdomen occurred post-operatively, and the wound healed soundly. The bowels were open on the following day. A protracted bronchopneumonia, however,

delayed the child's progress for some weeks. Ultimately he made an excellent recovery and was discharged on Dec. 29.

DISCUSSION

McSwain (1941) made a comprehensive review of the literature on this subject, and it is to his article we are largely indebted for the following facts. This author collected 75 authentic cases of intussusception of the appendix. Although the disease occurred in patients as widely separated in age as 13 months and 65 years, the preponderance of cases occurred in the first decade. Males were more frequently affected than females, in the proportion of 3 to 2. A striking fact about most of the cases was the long history, the average being eight months. Huddy (1927) divides the course of the disease into two stages—a first long period during which the appendix itself becomes intussuscepted, followed by a short acute phase of colic intussusception in which the inverted appendix acts as a foreign body in the lumen of the large bowel, in much the same way as a polypoid or pedunculated growth may act.

No uniform findings have been adduced to explain why the appendix should become inverted. An obvious cause such as a polypoid growth has only been reported in 5 cases and certainly in our case the appendix showed no obvious abnormality.

From his perusal of the literature McSwain finds that the intussusception may start either at the tip or at or near the base of the appendix, complete inversion into the cæcum being the end-result in either case. One case of retrograde intussusception of the appendix has been recorded. Forty-four of his collected cases were of one of these simple forms, but in 30 cases the appendicular inversion was associated with a cæco-colic or ileo-colic intussusception, as in our own instance. In only 6 cases has it been reported that the intussuscepted appendix was felt per rectum; in 2 of these cases the organ was actually amputated externally, but laparotomy proved necessary to reduce the colic intussusception.

A point of practical interest is that 2 cases were reported in which the stump of the recently amputated appendix formed the apex of a colic intussusception.

SUMMARY

A case is reported of complete inversion of the appendix into the cæcum, associated with cæco-colic intussusception. The intussusception had advanced so far that the appendix was palpable in the rectum. Operative treatment was successful. The pathology of the condition is discussed.

Our thanks are due to Dr. W. Allen Daley, Medical Officer of Health, London County Council, and Dr. J. H. Duke, late Acting Medical Superintendent of Highgate Hospital, for permission to publish this case.

REFERENCES

MOWAT, G. T. (1938), *Brit. J. Surg.*, **26**, 444.
MCSWAIN, B. (1941), *Sth. med. J., Nashville*, **34**, 263.
HUDDY, G. P. B. (1927), *Brit. J. Surg.*, **14**, 580.

SUCCESSFUL REPAIR OF A COMMON HEPATIC DUCT COMPLETELY SEVERED BY A FRAGMENT OF HIGH EXPLOSIVE

BY HAROLD PARK, BRIGHTON

A PENETRATING abdominal wound from enemy action involving only the main extra-hepatic bile-channel and a not inconsiderable artery in its immediate vicinity is an uncommon battle casualty; the surgical repair of the hepatic duct at the outlet of the portal fissure is certainly an infrequent operative experience in the abdominal surgery of war; a successful result in such a case is a matter of congratulation for the patient.

Sir Cuthbert Wallace (1922), writing on the abdominal surgery of the war of 1914–18, states that " the larger bile-passages do not seem to be so often wounded as might be expected ", and that these larger ducts " can be dealt with on ordinary lines by suture and drainage ". No account, however, is given of any specific case in which this operation was in fact performed or was successful in the article in the Official History of the last war or in any of the literature dealing with that conflict to which the writer has had access. It is true, however, that special mention in the article quoted is made of a fatal case where an injury to the hepatic duct necessitated an operation on the eighth day to evacuate a collection of bile in the pelvis. Surgeon Rear-Admiral Gordon-Taylor informs me that, although he dealt with several cases of injury to the gall-bladder and even the portal vein in the last war, he had never personally operated upon an injury of the main bile-channel produced by a penetrating wound in that conflict, nor had he himself been vouchsafed the opportunity of witnessing such an operation in any of the Casualty Clearing Hospitals in which he worked a quarter of a century ago. The lesion is probably very rare as an isolated condition; the proximity of the extra-hepatic ducts to the big blood-vessels of the abdomen doubtless explains the infrequency of the injury as revealed at laparotomy.

A survey of the limited literature dealing with the abdominal surgery of the present war has revealed only two cases recorded so far of injury to the gall-bladder and extra-hepatic biliary passages: one was a perforated gall-bladder complicated by an injury to the liver, and the other a possible rupture of the common bile-duct due to 'blast'.

The following is an account of a gunshot wound of the abdomen causing a complete severance of the common hepatic duct followed by recovery after end-to-end anastomosis of the duct.

CASE REPORT

HISTORY.—Leslie R., aged 21, an able-bodied seaman, sustained a penetrating wound of the abdomen together with a compound fracture of the right elbow-joint during action at about 4.30 a.m. on Aug. 19, 1942. He was admitted to hospital under my care with a convoy of wounded about sixteen hours later. His temperature was 97°; pulse 120; respiration 24. He was shocked and in pain, although he had received morphia, gr. $\frac{1}{3}$, together with 3000 units of antitetanic serum some time earlier. He was at once treated for shock and given morphia, gr. $\frac{1}{4}$, and 2 pints of plasma. Examination of the abdomen revealed a penetrating wound the size of a finger-tip in the left hypochondrium; there was no exit wound. The abdomen was tender to touch and rigid in its upper half; there was no diminution of liver dullness; breathing was thoracic in character; the urinary bladder was distended. A wet-plate X-ray film failed to reveal a foreign body in the peritoneal cavity, but the faint shadow of a metallic object could be seen some hours later in the dry film. A diagnosis of early peritonitis was made, and the patient prepared for laparotomy.

OPERATION FINDINGS (*Fig.* 177).—Roughly 19 hours after the injury had been sustained the abdomen was explored through a left paramedian incision incorporating at its upper end the entrance wound. The peritoneal cavity contained a good deal of blood; there was no escape of gas and no fæcal odour. The contents of the abdomen were systematically examined; the search at first disclosed no source for the hæmorrhage, and the abdomen was about to be closed, when retraction of the wound edges revealed œdema of the retroperitoneal tissues in Morison's pouch; the blood mopped up from this area was noticeably mixed with bile.

A finger was passed into the foramen of Winslow and a piece of shrapnel 1·5 cm. × 0·5 cm. was felt lying in the free margin of the gastro-hepatic omentum; the common hepatic duct was found to be completely divided. Hæmorrhage was taking place from a large vessel the identity of which could not be ascertained owing to œdema of the tissues. The foreign body was removed and the bleeding vessel ligatured. An attempt to find the proximal end of the duct, which had apparently retracted into the porta hepatis, was unsuccessful; the condition of the patient did not permit any prolonged search. The liver was undamaged. A drainage tube was sutured to the tissues in the region of the duct and the abdomen was closed. On return to the ward a transfusion of 2 pints of blood was given.

SUBSEQUENT PROGRESS.—The drainage-tube was retained for three weeks, during which time bile drainage averaged about a pint daily. Bile-salts in the form of bilein capsules were given from the second post-operative day. The stool was soon of normal colour; there was no bile in the urine and the patient's appetite was good. During the third week he was allowed up with the biliary fistula still discharging. On Sept. 21, 1942, the patient had an attack of cholangitis accompanied by pyrexia, rigors, and jaundice, with a clay-coloured stool and bile in the urine. Bile drainage ceased for twelve hours on this occasion.

Pathological findings at that time were as follows:—

Van den Bergh, direct	= Positive. Light red in 30 min.
Quantitative, indirect	= 1·2 mg. bilirubin per cent
Takata-ara	= Positive
Bile on culture	= *B. pyocyaneus*
Blood-picture:—	
Hb	= 85 per cent
R.B.C.	= 4,170,000
W.B.C.	= 7,500
Differential count	= 60 per cent polymorphs 40 per cent lymphocytes

From this time onwards the conjunctiva had an icteric tinge and bile was frequently present in the urine. The stools no longer contained bile.

A month later bile drainage stopped for 72 hours and was accompanied by a more severe attack of cholangitis. Both attacks were treated with intravenous cylotropine and glucose salines.

Bile drainage gradually diminished, and ceased entirely on Nov. 1, 1942, about eleven weeks after the fistula had been established. Duodenal intubation at that time revealed no bile in any of the specimens aspirated, and a blood-picture showed a mild hypochromic anæmia. For a week following the spontaneous closure of the fistula the patient remained well apart from a slight conjunctival icterus. Gradually deepening jaundice then ensued and with it the patient's general condition deteriorated. It was decided to attempt to reconstitute the duct, and daily injections of vitamin K and calcium were administered along with the intravenous glucose saline for about a fortnight.

RECONSTRUCTION OF COMMON HEPATIC DUCT, Dec. 5, 1942.—Under spinal anæsthetic (percaine, 1–1500) the abdomen was opened by a Kocher's subcostal incision. Dense adhesions were immediately encountered, and a pseudo-cyst containing three-quarters of a pint of white bile was found on the under surface of the liver medial to the gall-bladder, which was collapsed and empty and reduced in size. Exposure of the proximal end of the common hepatic duct presented relatively little difficulty, for although it was less than half an inch in length it was dilated (*Fig.* 178). The duct was slit up with scissors and a profuse flow of white bile ensued. The identification of the distal segment of the main bile-channel, however, was much more difficult; it was eventually found by traction on the shrunken gall-bladder and cystic duct after a retrograde cholecystectomy had been performed. The distal portion of the divided duct was coiled upon itself like the frond of a fern and buried in adhesions. After freeing the duct, whose diameter was much reduced, a fine Lister's bougie was passed into the duodenum. An endeavour was now made to unite the cut ends of the hepatic duct over a T-tube; one limb of the tube passed into the intra-hepatic duct quite easily, but the distal limb buckled on itself and began to tear the atrophic wall of the lower segment, and the manœuvre was abandoned. In the end union was achieved by approximating the freshened cut ends of the duct by means of three interrupted plain catgut sutures, two posterior and one anterior, without the use of a tube (*Fig.* 179). Loose fatty tissue in the neighbourhood was used to

bury the site of union and the abdomen was closed with drainage.

FURTHER PROGRESS.—Drainage of the white bile continued for a week and was followed by decreasing amounts of normal bile for a further three weeks. The jaundice gradually disappeared and the patient put on weight. He was discharged from hospital on March 4, 1943, his blood-picture being normal, the blood-urea was 33 mg. per cent, and a hippuric acid excretion test gave 80 per cent normal excretion. The stools were normal in every way.

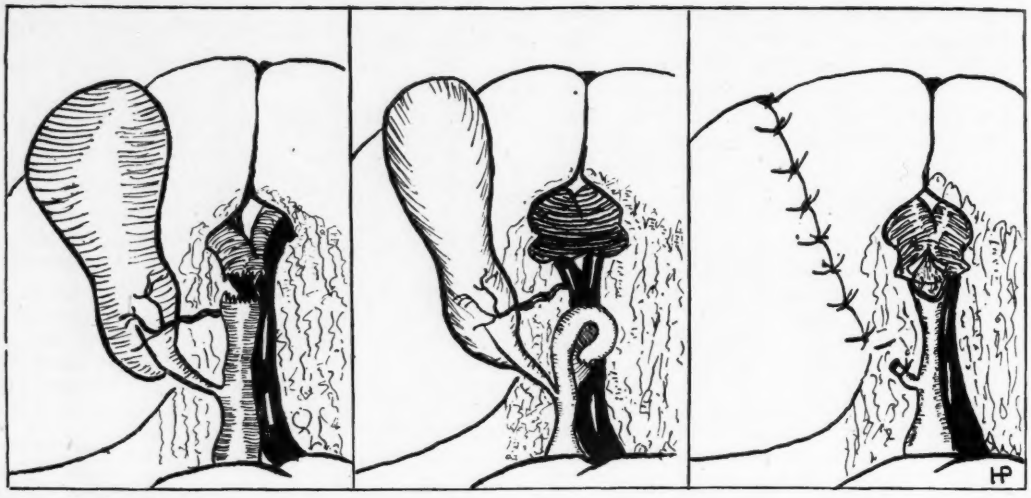


Fig. 177 *Fig.* 178 *Fig.* 179

FIG. 177.—Injury as seen at time of the first operation.
FIG. 178.—Findings at the second operation. Showing collapsed gall-bladder and distorted common hepatic duct.
FIG. 179.—Reconstruction of the duct after cholecystectomy.

COMMENTARY

The direction of the projectile from left to right across the upper abdomen might be expected to result in injury to adjacent viscera such as the stomach; the fact that no other lesion resulted was fortunate and remarkable.

The identity of the artery which was the source of the considerable hæmorrhage at the first laparotomy must remain a matter of speculation. Although the right branch of the hepatic artery was regarded at the time as the injured vessel, the absence of any signs of liver failure and the smoothness of the early convalescence seem to negative the probability of the hepatic artery or either of its two main terminal branches being the damaged blood-vessel. The literature credits interference with the main arterial supply of the liver with a heavy death-rate; thus Alessandri collected 10 cases of ligature of the hepatic artery for conditions other than aneurysm and found a mortality-rate of 60 per cent; the results of ligature of the right or left branch of the hepatic artery for non-aneurysmal conditions are not much more encouraging, since the Axis writer above-mentioned found a death-rate of 40 per cent from the procedure, the fatal cases almost always exhibiting necrosis of the corresponding liver lobe.

The less baleful results of the experimental ligation of the hepatic arterial tree in animals are at variance with the unfortunate experience of those who perchance or perforce have interfered with the blood-supply of the liver in man.

The cystic artery was certainly ligatured at the second operation when the shrunken gall-bladder was removed; possibly an accessory hepatic artery was either the wounded structure or alternatively the conduit able to supply the denuded hepatic area, if in fact the right branch of the hepatic artery was injured by the fragment of high explosive and ligated at the first operation.

The arterial supply of the liver is of course liable to considerable variation. Thus Henle reported a case in which 3 hepatic arteries were present: from (*a*) the left gastric; (*b*) the parent cœliac axis; (*c*) the superior mesenteric. Branco also described a triple arterial supply in another case: (*a*) a special artery from the cœliac axis; (*b*) the usual origin from the cœliac axis; (*c*) a special branch from the superior mesenteric to the right lobe. The not infrequent derivation of the left hepatic artery from the coronary (left gastric) is vouched for by Quain, and this same indisputable authority affirms the occasional origin of the left hepatic from the superior mesenteric, and its rare source from the splenic artery.

Quain also vouchsafes the information that accessory hepatic arteries are sometimes encountered and generally come from the coronary. Such a hepatico-coronary artery is said by Rabinovitsch (1927) to occur in no less than 28 per cent. According to Quain, an accessory hepatic artery comes less frequently from the superior mesenteric, aorta, right renal, or inferior mesenteric; Rabinovitsch describes such an accessory hepatico-mesenteric artery in 18 per

cent. Thus, according to Rabinovitsch, an accessory artery is present in nearly half the cases. Tandler suggests that 32 per cent perhaps represents the frequency of an accessory hepatic artery.

The patient whose case is quoted here was probably the fortunate possessor of such an accessory arterial supply.

The experience of others encouraged the hope that spontaneous closure of the biliary fistula which followed the first operation would result in spite of the separation of the two segments of the hepatic duct, and the early weeks of convalescence with the presence of normal-coloured stools flattered those hopes.

That bile should ever have found its way from the severed duct in the portal fissure down into the lower moiety of the main bile-channel and into the duodenum seemed remarkable indeed at the second laparotomy, when the wide separation of the two portions of the bile-channel was demonstrated and the coiled, obturated distal choledochus was only disclosed after a troublesome and anxious dissection.

The average loss of a pint of bile daily from the fistula appeared to have no effect on the rate of production of hæmoglobin, which is said to be halved when all the bile is lost in a biliary fistula, as only a minor degree of anæmia occurred.

SUMMARY

The case is presented of a naval rating whose hepatic duct was severed by a fragment of high explosive afloat and who suffered from considerable hæmorrhage from an unidentified artery in the gastrohepatic omentum. Recovery followed a primary laparotomy which arrested hæmorrhage and a subsequent operation which restored the continuity of the main bile-channel.

It is a pleasure for me to record my gratitude to Surgeon Rear-Admiral G. Gordon-Taylor, Consultant Surgeon to the Royal Navy, for his helpful advice and criticism in the treatment of this case and for the privilege of assisting him at the second operation which he performed. My thanks are also due to Dr. S. J. Firth, Medical Director of the Brighton Municipal Hospital Services, for his personal interest in the publication of this case.

REFERENCES

GORDON-TAYLOR, GORDON (1943), *Brit. med. J.*, **1**, 504.
— — (1942), *Abdominal Surgery of Total War* (60th Bradshaw Lecture).
HUGGINS, C., and POST, J. (1937), *Arch. Surg.*, **35**, 878.
LEWIS (1938), *Ann. Surg.*, **108**, 237.
RABINOVITSCH, F. S. (1927), *Zbl. Chir.*, **54**, 1943.
RUDBERG (1922), *J. Amer. med. Ass.* (Abstr.), **79**, 1562.
WALLACE, SIR CUTHBERT (1922), *Official History of the War, Medical Services. Surgery of the War*, **1**, 545.
WRIGHT (1940), *Applied Physiology*, 7th ed., **364**.

REVIEWS AND NOTICES OF BOOKS

The Principles and Practice of War Surgery. With Special Reference to the Biological Method of Treatment of Wounds and Fractures. By J. TRUETA, M.D., Assistant Surgeon (E.M.S.), Wingfield-Morris Orthopædic Hospital, Oxford; Acting Surgeon-in-Charge, Accident Service, Radcliffe Infirmary, Oxford; Formerly Director of Surgery, General Hospital of Catalonia, University of Barcelona. 9¼ × 6⅛ in. Pp. 391 + xvi, with 136 illustrations. 1943. London: William Heinemann (Medical Books) Ltd., in conjunction with Hamish Hamilton Medical Books. 42s. net.

FOR a variety of reasons this war has as yet produced few outstanding advances or fundamental changes in surgical methods; such contributions as have appeared have borne evidence of preparation under the stress of war conditions. Dr. Trueta's new book has no such limitations, for it is the logical and detailed account of a method of treatment which has been developed over a period of years and has been used in over a thousand cases in the Spanish War and in many others treated in this country during the present conflict.

The book consists of two main parts, the first devoted to principles, the second to practice, and if on reading the first part we are at times inclined to think that the principles have been made to fit the practice, we must remember that we have already been made familiar with the method by the author's previous writings.

Whilst there is admittedly little that is new in the first part, it has the effect of directing our attention particularly to those processes of healing and the factors which interfere with it which receive practical confirmation from the results of treatment. Stress is laid on the importance of the lymphatic paths in the initial spread of infection, and the moral is drawn that the business of the surgeon is to reduce the inflow of bacteria by early and thorough treatment of the wound. Anaerobic infections receive detailed consideration, shock is discussed from the clinical viewpoint and on a regional basis, and the importance of traumatic vascular spasm in its production is explained. The value of blood transfusion is fully recognized, the author, perhaps naturally, preferring the method devised in Barcelona. Anæsthesia for war casualties is discussed in a separate chapter, the conclusion being that ether is probably the best and safest anæsthetic for general use.

The second part begins with a summary of the basic principles upon which successful treatment rests; they are embodied in a five-point programme which comprises: (1) Prompt surgical treatment; (2) Cleansing of the wound; (3) Excision of the wound; (4) Provision of drainage; (5) Immobilization in a plaster-of-Paris cast.

Whilst every item is vital, success depends most on proper excision of the wound, and without this the other four points lose much of their value; the whole method relies on the interdependence of all five points. Prompt surgical treatment demands efficient organization; the elimination of the first-aid post for all but minor casualties was advocated by Dr. Trueta at the beginning of the war and experience with air-raid casualties in this country has confirmed its wisdom. It does, however, demand skilled sorting of the casualties at the site of the incident, and the organization described is perhaps rather too dependent on the integrity of the telephone service. The types of air-raid casualty described conform to those which we have met here; mention might have been made of the general dirtiness of such patients in an urban area, for the removal of dust, plaster, and grime is time consuming and presents a serious problem which may cause considerable delay in operation, as it interferes to some extent with resuscitation.

We cannot agree entirely with the statement that blast injuries present no problem from the surgeon's point of view; abdominal blast injuries are amongst the most difficult in diagnosis.

It is refreshing to find soap restored to its place as the best antiseptic for war wounds, not only for the skin but for the wound itself.

Chemotherapy is advocated, by mouth or intravenously, and the local application of one of the sulphonamides is approved as a prophylactic, but is rightly condemned where local infection is already established. Chemotherapy is no substitute for efficient excision, or for drainage of retained pus. Amongst the complications of chemotherapy there is no account of anuria, and sulphapyridine hæmaturia is but briefly mentioned.

The surgical treatment of a recent war wound is clearly described in detail; it starts with enlargement of the wound by incision and continues by removal of all devitalized tissue, layer by layer, by excision. We are pleased to see the use of scissors advocated instead of the knife, especially in excising muscle, and the further stress laid on prompt surgical treatment by the omission of X-ray examination of a fracture except where a joint is involved. Close-mesh dry gauze is used for drainage, and packing with vaseline gauze is reserved for infected wounds. Immobilization is by means of unpadded plaster-of-Paris, and both the pattern and bandage techniques are described, with their relative merits. Skin-grafting is discussed from the angle of the general rather than the plastic surgeon, attention being drawn to the Corachán type of graft as being of particular value in war wounds. Amputation and wounds of joints each receive a separate chapter, and the author recognizes the need for a guillotine amputation in some war wounds; amputations are treated like other wounds in that they are encased in plaster. The same material is also used for burns, but the evidence brought forward in its favour is rather scanty.

Those who have treated war wounds on the principles here described will be enthusiastic in their praise of this book; those who have not should at least be stimulated to try the method, and the detailed descriptions will give them no excuse for neglecting any of the requisite steps. One might cavil at the title as being suggestive of something more comprehensive than a work which deals almost exclusively with wounds of the limbs, but the abdominal surgery of warfare is in a different category. The author is to be congratulated on such a clear exposition of his subject, and thanked for collecting the results of his researches and experiences into this compass without detracting from their interest. We give the book a warm welcome and predict that it will become recognized as one of the standard works on war surgery.

Pictorial Handbook of Fracture Treatment. By EDWARD L. COMPERE, M.D., F.A.C.S., Associate Professor of Surgery, Northwestern University Medical School; etc.; and SAM W. BANKS, M.D., Associate in Surgery, Northwestern University Medical School; etc. 8 × 5½ in. Pp. 351 + x, with 171 illustrations. 1943. Chicago: The Year Book Publishers Inc. (London: H. K. Lewis & Co.). 27s. net.

BOOKS on fractures are many and varied, but this volume of some three hundred and fifty pages is for the most part pictorial in character. There are one hundred and seventy-one illustrations, which works out to one every other page of text. Some of the illustrations are in black and white, while others are half-tones, and there are a goodly number of excellent X-ray reproductions.

The text is terse, yet lucid, and is quite sufficient to explain and amplify the illustrations.

This book should prove of real worth to medical officers in the fighting forces and to those medical men who are situated in isolated districts, for it gives them just the information they require.

Synopsis of Traumatic Injuries of the Face and Jaws. By DOUGLAS B. PARKER, M.D., D.D.S., Associate Professor, Department of Oral Surgery, School of Dental and Oral Surgery, Columbia University. 7⅝ × 5 in. Pp. 334, with 229 illustrations. 1942. London: Henry Kimpton. 22s. 6d. net.

THIS monograph of over 300 pages deals with the various injuries which may occur to the face and jaws in civil and military life. Some of the war material in the book dates from the last war, while other clinical cases from the present conflict are incorporated.

Perhaps the most important chapter of the book is that devoted to the stabilization of fractures; all the modern methods of splinting and fixing fractures of the jaw are well described and illustrated.

Various methods of reconstruction of the mouth and face are set out, and the use of Padgett's dermatome in skin-grafting operations is encouraged.

The problems of anæsthesia in the surgery of the face, mouth, and jaws are described, and the various methods of overcoming them are dealt with in a very lucid and practical way.

Surgeons in the fighting forces and those engaged in civil practice will find this book a useful guide to what is in reality a branch of general surgery.

First Aid in the Royal Navy. 7⅛ × 4¾ in. Pp. 106, with 63 illustrations. 1943. London: H.M. Stationery Office. 2s. net.

THE first half of this little book is devoted to a consideration of the commoner problems of first aid—shock, bleeding, wounds, fractures, burns. Nowhere could be found better or clearer instruction to the layman on how he should deal with these conditions. The principles and object of treatment are admirably described in simple language devoid of technicalities. The mass of details which mar the majority of first-aid primers is avoided; e.g., only two pressure points—the brachial artery and the femoral artery in the groin—are mentioned.

The remainder of the book consists of articles which are of especial importance in service afloat—

movement and stowage afloat, first aid to survivors, poison gases, heat exhaustion, etc.

The book is well printed, and, for the most part, well illustrated, though *Figs.* 11 and 26 are indistinct. No other criticism can be made apart from regret at the absence of an index. On the whole, it is an excellent presentation of the subject.

Sea Diseases. The Story of a Great Natural Experiment in Preventive Medicine in the Royal Navy. By R. S. ALLISON, V.D., M.D., F.R.C.P. With a Foreword by SHELDON DUDLEY, C.B., O.B.E., F.R.S., M.D., F.R.C.P., K.H.P. 8⅝ × 5⅝ in. Pp. 218 + xxiii, with 12 illustrations. 1943. London: John Bale Medical Publications Ltd. 25s. net.

THIS is a book dealing with the health of the Royal Navy from the sixteenth to the nineteenth century, and it reveals the very important part that preventive medicine plays in the Senior Service.

The health of the seamen in ancient times was precarious, and no wonder, for they lived in foul quarters and their food was dreadful. Scurvy and fevers were a constant drain on the English fleet, and it was not until Lind, Blane, Trotter, and Burnett came on the scene that these diseases, together with dysentery and typhus, were driven off the sea.

This little book contains a wealth of information which will interest the medical profession as a whole; but all Medical Officers joining the Royal Navy will find it not only a useful insight into the past, but fascinating in its account of diseases that are not seen to-day.

Rose and Carless Manual of Surgery. For Students and Practitioners. By CECIL P. G. WAKELEY, C.B., D.Sc., F.R.C.S., F.R.S.E., F.R.S.A., F.A.C.S., F.R.A.C.S., Senior Surgeon, King's College Hospital, London, etc.; and JOHN B. HUNTER, *M.C.*, M.Chir., Cantab., F.R.C.S. Eng., Surgeon, King's College Hospital, etc. Seventeenth edition. In two volumes. 8¾ × 5⅝ in. Vol. I, pp. 840 + xx, with 501 illustrations and 10 plates; Vol. II, pp. 926, with 599 illustrations and 20 plates. 1943. London: Baillière, Tindall & Cox. 35s. net.

THE present edition is the second to be published since the war began, and includes new matter on blood transfusion, war burns, blast, the crush syndrome, and other aspects of the surgery of modern warfare. This text-book may justly be described as a singularly complete and well-balanced account of modern surgical practice, and the publishers deserve commendation for the high quality of this wartime production. It is clearly printed and amply illustrated and its already well-established appeal to English-speaking students the world over will be increased by the present edition. Fault may, perhaps, be found with certain illustrations; thus Plate VI, which claims to show the position of a needle in the foramen ovale, is not very helpful as the point of the needle does not appear; the illustration (*Fig.* 166) of a leiomyoma of the median nerve, p. 394, would, perhaps, be better omitted from a student's text-book, while the curved incision shown in *Fig.* 139 (p. 344) for ligature of the middle meningeal artery may be criticized as the base of the flap is narrow and may lead to necrosis; a vertical incision as shown in *Fig.* 171 (p. 403) for approach to the Gasserian ganglion is better in this respect.

The operative surgery of intracranial lesions is well illustrated and described, but a more complete description of cerebral contusion and the consequences of traumatic brain swelling, with its treatment, would be helpful in a student's text-book. The chapter on war surgery is a valuable addition, and few will disagree with its concluding paragraph, "Surgical common sense is far more valuable in the treatment of war wounds than any hard and fast rules which may from time to time be issued to the Services", a reminder that this war is no exception to the general rule that all campaigns produce much paper in the form of memoranda even when there is an acute paper shortage!

As this deservedly popular text-book advances towards its half centenary, which it reaches in a few years' time, it keeps well up to date. Many practising surgeons to-day recall with affection the earlier editions which guided us so well in our student days. This edition can confidently be recommended to do the same for the students of to-day.

The Hemorrhagic Diseases and the Physiology of Hemostasis. By ARMAND J. QUICK, Ph.D., M.D., Associate Professor of Pharmacology, Marquette University School of Medicine, Milwaukee, Wisconsin. 9½ × 6⅛ in. Pp. 340 + xx, with 24 illustrations. 1942. Springfield, Ill.: C. C. Thomas. (London: Baillière, Tindall & Cox.) 27s. 6d. net.

IN Leviticus xvii. 11 et seq. we read: "For the life of the flesh is in the blood. . . . For it is the life of all flesh: the blood of it is for the life thereof, therefore I said unto the children of Israel ye shall eat the blood of no manner of flesh for the life of all flesh is the blood thereof."

So wrote Moses, and as long as surgery is practised the control of hæmorrhage must be one of the mainstays on which its successful practise depends.

It is fitting, therefore, that surgeons should take notice of an authoritative monograph such as this, written by Prof. Quick, whose name is so well known in connexion with the problems of blood coagulation, which is the natural and only permanent method of controlling hæmorrhage. It is difficult to resist the temptation to make a pun on the name of the author, but "the man who could make so vile a pun would not scruple to pick a pocket", so it were better to pick the information from the book.

It begins, as is proper, with a historical survey of the subject and then reviews the present-day theories of the physiology of the clotting of blood. Little could be known until the construction of the microscope was an accomplished fact. It is not surprising therefore, that though Malpighii, in 1666, noticed a mass of white fibres after a blood-clot was washed, it was not until 1795 that fibrin was named and described, and 1859 before its precursor fibrinogen was established.

In 1890 Arthus and Pagès discovered that coagulation could not occur in the absence of calcium and that sodium oxalate prevented clotting. The anticoagulation action of sodium citrate remained difficult to interpret until Sabbatini in 1901 showed that citrate depressed the ionic calcium.

The classical theory of Morawitz is accepted to explain coagulation, other theories are indicated, but not detailed; due acknowledgement is given to the work of Howell and Mellanby, and the author modestly does not overstress his own work, which has been so important. Interesting references to surgical physiology abound: for instance, the role of 'fibrin' in healing, the reason for canalization of thrombosed vessels, the influence of the liver on fibrinogen formation, the fact that menstrual blood is defibrinated, the

reason for cadaver blood remaining fluid, and also the absence of clotting in hæmorrhagic exudates. The phenomena of agglutination and phagocytosis is explained, and very tentatively but attractively a theory is suggested to explain the action of sulphonamdies. Thromokinase is derived from platelets. Their importance is such that "The blood-platelet is the most fundamental factor in hæmostasis. It appears to participate in all the known mechanisms utilized by the body to control the loss of blood."

The factors participating in coagulation are: calcium, prothrombin, thromboplastin, fibrinogen, and thrombin. The anticoagulants act by interfering with one or more of these factors. The rationale of the action of heparin is given in great detail. Interesting statistics are given to illustrate the use of heparin in preventing post-operative pulmonary embolism. Its use is also discussed in the prevention and treatment of thrombosis of the portal vein after gastrectomy, thrombosis of the central vessels of the retina, inferior cerebellar artery, mesenteric and coronary vessels, and in the after-treatment of embolectomy. It will probably be found to be of great use in the prevention of peritoneal adhesions and also, combined with sulphonamides, in the treatment of subacute bacterial endocarditis. It is given intravenously, 25–30 drops a minute of a mixture of 500 c.c. of physiological saline containing 10 c.c. of heparin (10,000 units). The dose should be checked by estimating the clotting time of the blood, which should be maintained at 30 minutes.

Quick's name is best known for his work on vitamin K and prothrombin. His method of estimation of the prothrombin in the blood is given in detail. The importance of this estimation in obstructive jaundice is that he thinks an evaluation of liver function can be most rapidly and accurately made by the response of the amount of prothrombin in the blood to vitamin-K therapy. If given by the mouth in these cases then bile-salts must be given as well. The importance of building up a reserve of vitamin K in these cases is shown by the fact that jaundiced people do not, except rarely, die of hæmorrhage if no operation is done; and the hæmorrhage may only occur some time after the operative procedure. The occurrence of hæmorrhage in jaundice was noted in 1680, but it was not until 1934, with the discovery of vitamin K, that the elucidation of this enigma began.

The physiology and pathology of the hæmorrhagic diseases is fully discussed—pseudo-hæmophilia, which affects both males and females and is hereditary, is put in its proper relation to hæmophilia. It may explain some of those cases, so worrying to the surgeon, of unaccountable hæmorrhage after tonsillectomy, gastric operations, tooth extraction, etc., but this disease should not be used as a refuge for faulty surgical technique.

Hæmophilia has naturally a chapter to itself. The author begins: "It would be difficult to find a disease more tragic and dramatic, and it equals tuberculosis, syphilis, and insanity in shaping the destiny of present-day Europe". It was not recognized until the nineteenth century, though its symptomatology is given in the Bible. Moreover, it is probably unique in that Dr. John C. Otto, who published the classical account in 1803, "An account of an hæmorrhagic disposition existing in certain families", had never seen a case. He does, however, give the sources of his information.

The whole book is very readable, in parts almost exciting, and it can be strongly recommended to all practising surgeons and anyone who is seeking for a physiological explanation of certain surgical symptoms.

The Students' Handbook of Surgical Operations. By Sir FREDERICK TREVES, Bart., G.C.V.O., C.B., LL.D., F.R.C.S. Seventh edition, revised by CECIL P. G. WAKELEY, C.B., D.Sc., F.R.C.S., F.R.S.E., F.A.C.S. (Hon.), F.R.A.C.S., Fellow of King's College, London; Senior Surgeon to King's College Hospital; etc. $7\frac{1}{8} \times 4\frac{3}{4}$ in. Pp. 562 + xii, with 265 illustrations. 1943. London: Cassell & Co. 12s. 6d. net.

A BOOK which is still in demand after over fifty years of life needs no introduction, and this seventh edition, the first new one since the war, fully maintains the high standard of its predecessors. One of the reasons for its continued popularity is that it has kept the same form throughout, and alterations have been introduced gradually. Most of the original illustrations have been retained and in clarity they compare favourably with the new additions. Although there is much new material there are only ten more pages than in the edition of nineteen years ago; this has been achieved by the omission of obsolete operations, and the volume is still a handbook. As a guide to the fundamental principles of operative surgery, it remains without equal; for the student who has operations to perform as an examination test, it is the best mentor, and he will be wise who remembers that old friends are best.

BOOK NOTICES

[The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest for our readers.]

The Practice of Local Anæsthesia. By GEORGE BANKOFF, M.D., D.Ch., F.R.F.P.S., F.R.C.S.E., E.M.S. Surgeon, St. John and St. Elizabeth Hospital; Surgeon, Italian Hospital; etc. Revised edition. $8\frac{1}{2} \times 5\frac{1}{2}$ in. Pp. 244, with 181 illustrations. 1943. London: William Heinemann (Medical Books) Ltd. 17s. 6d. net.

A Pocket Surgery. By PHILIP H. MITCHINER, C.B.E., T.D., M.D., M.S. (Lond.), F.R.C.S. (Eng.), D.Ch. Hon. (Durham), D.L., Honorary Surgeon to H.M. The King, Surgeon and Lecturer in Surgery, St. Thomas's Hospital; etc.; and A. HEDLEY WHYTE, D.S.O., M.B., M.S. (Durham), F.R.C.S. (Eng. and Edin.), Honorary Surgeon, Royal Victoria Infirmary, Newcastle-on-Tyne; etc. $7\frac{1}{4} \times 4\frac{3}{4}$ in. Pp. 272 + viii, with Frontispiece. 1943. London: J. & A. Churchill, Ltd. 10s. 6d. net.

Endoscopic Prostatic Surgery. By ROGER W. BARNES, M.S., M.D., F.A.C.S., Professor of Clinical Urology, College of Medical Evangelists; Chief of Urology, White Memorial Hospital and Out-patient Clinic; Senior Attending Surgeon, Los Angeles County Hospital. 10 × $6\frac{7}{8}$ in. Pp. 232, with 104 illustrations. 1943. London: Henry Kimpton. 30s. net.

A NEW "Emesay" product worthy of note!

The ROYAL FREE HOSPITAL MULTIPOISE TABLE

Trendelenburg Position with Third Section Angulated to Relax Abdominal Muscles.

An "ALL PURPOSE" general operation table of modern design embodying many new features.

FOUR-SECTION TABLE TOP giving every position required by modern technique.

TRENDELENBURG POSITIONS actuated by one control.

Built-in ADJUSTABLE GOITRE REST.

SPECIAL FITTINGS for Thoracoplasty, Skull and Gynæcological operations.

Heavy "Emesay" quadruped base affords effortless mobility and rigid fixation.

We invite you to write for a copy of the new descriptive leaflet dealing with this excellent table, sent free upon application.

SHOCK RESUSCITATION AFTER AIR RAIDS

APPLIED HEAT A VITAL NECESSITY

★ *Simply and speedily operated.* ★ *Thermostat control ensures safe level temperature.* ★ *Easily stored.* ★ *Inexpensive and hygienic.* ★ *A series of cages may be operated from a single power plant.*

Air raid casualties are especially prone to secondary shock. To-day's problem, therefore, is how best to combat immediately loss of body heat when a number of casualties have to be dealt with simultaneously, following intensive aerial attack.

The 'Restor' Shock Cage is the most satisfactory solution as proved by its successful use in the largest hospitals and first-aid stations throughout the United Kingdom. It is the most reliable, economical and hygienic method of using applied heat.

The 'Restor' keeps the patient at a uniform temperature, thermostatically controlled. There is no electrical danger . . . fuses are protected and the cages are 'earthed.' Operated by electrical power a multi-connector makes it possible to run up to thirty cages from one power point.

First cost is small, current consumption light, and labour reduced to the turning of a switch.

Please write for Bulletin No. R.S.C. 840 which fully describes the unique features of the 'Restor' Shock Cage.

THE MEDICAL SUPPLY ASSOCIATION LTD

167-173 GRAYS INN ROAD, LONDON, W.C.1. Telephone: Terminus 5432

Sheffield · Edinburgh · Liverpool · Dublin

INSTRUMENTS FOR

INTRACAPSULAR FRACTURES OF FEMORAL NECK

and

Arthrodesis of the Hip

Hip Arthrodesed by Extra-articular Technique (without denuding Articular Cartilage) by a Heavy Gauge Three Flanged Nail and Cross Pin.

DOWN BROS. LTD.

Surgical Instrument Makers

All Correspondence—23 Park Hill Rise, Croydon. *Tele.*: CRO 6133

LONDON:

SHOWROOMS: 22A CAVENDISH SQUARE, W.1. *Tele.*: MAY 0406

TORONTO:

143 COLLEGE STREET

PRINTED BY JOHN WRIGHT AND SONS LTD., BRISTOL, ENGLAND